US007114793B2

(12) **United States Patent**
Katsuta et al.

(10) **Patent No.: US 7,114,793 B2**
(45) **Date of Patent: Oct. 3, 2006**

(54) **RECORDING APPARATUS**

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(73) Assignee: **Fuji Xerox Co., Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 198 days.

(21) Appl. No.: **10/778,036**

(22) Filed: **Feb. 17, 2004**

(65) **Prior Publication Data**

US 2004/0227785 A1 Nov. 18, 2004

(30) **Foreign Application Priority Data**

Feb. 17, 2003 (JP) 2003-037854
Aug. 19, 2003 (JP) 2003-295649

(51) **Int. Cl.**
B41J 2/165 (2006.01)

(52) **U.S. Cl.** **347/22**; 347/29; 347/32

(58) **Field of Classification Search** 347/22, 347/23, 24, 29, 30, 31, 32, 33
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,739,340	A *	4/1988	Terasawa	347/30
5,040,000	A *	8/1991	Yokoi	347/30
5,455,609	A *	10/1995	Gast et al.	347/32
6,270,183	B1 *	8/2001	Gaarder	347/29
2004/0179062	A1 *	9/2004	Rai et al.	347/42

FOREIGN PATENT DOCUMENTS

JP	A 2-179754	7/1990
JP	A 3-92358	4/1991
JP	11-348313	* 12/1999
JP	2000-015835	* 1/2000

* cited by examiner

Primary Examiner—Huan Tran
(74) *Attorney, Agent, or Firm*—Oliff & Berridge, PLC

(57) **ABSTRACT**

A recording apparatus contains a recording head having a liquid droplet ejecting surface and ejecting a liquid droplet to a recording medium, a maintenance device disposed at a position opposite to the liquid droplet ejecting surface of the recording head, and a conveying unit which conveys the recording medium between the recording head and the maintenance device. The maintenance device has a liquid housing unit which houses the liquid droplet from the recording head, and a cleaning unit which cleans the liquid droplet ejecting surface of the recording head.

33 Claims, 33 Drawing Sheets

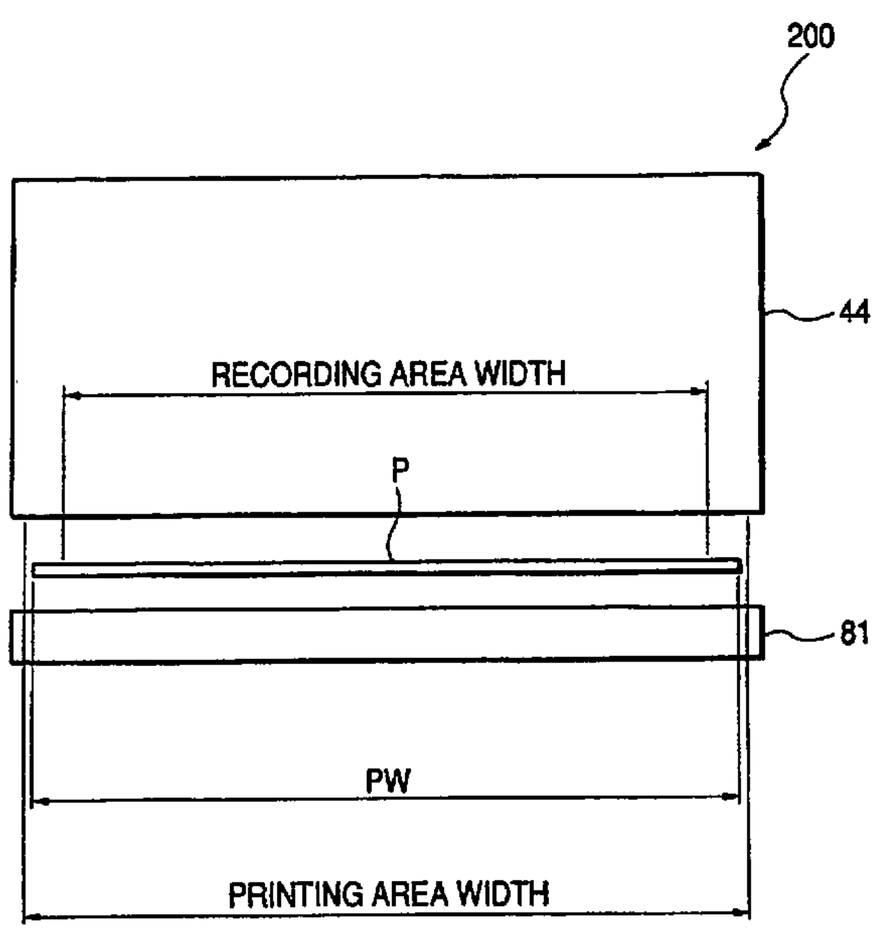


FIG. 1

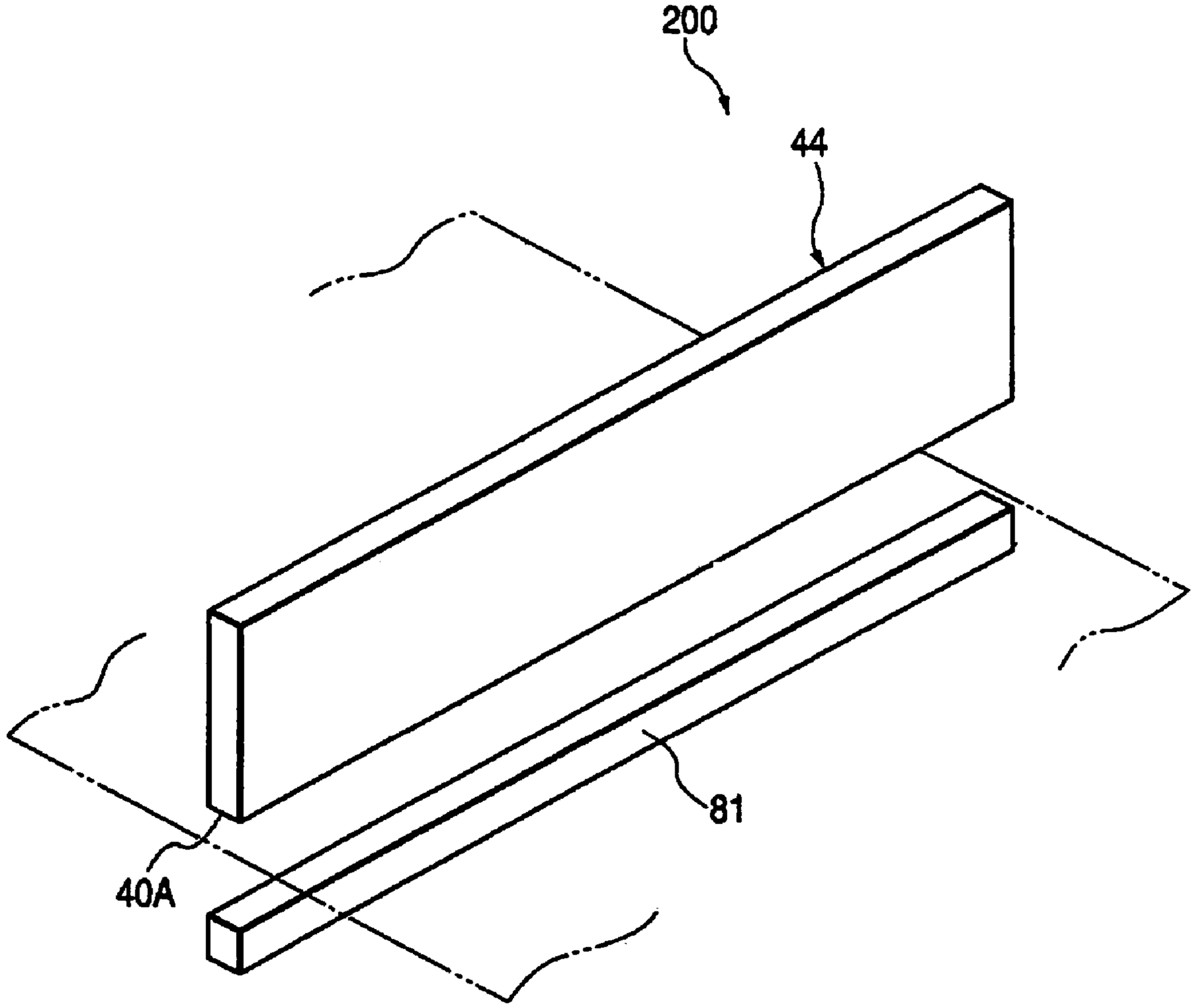


FIG. 2

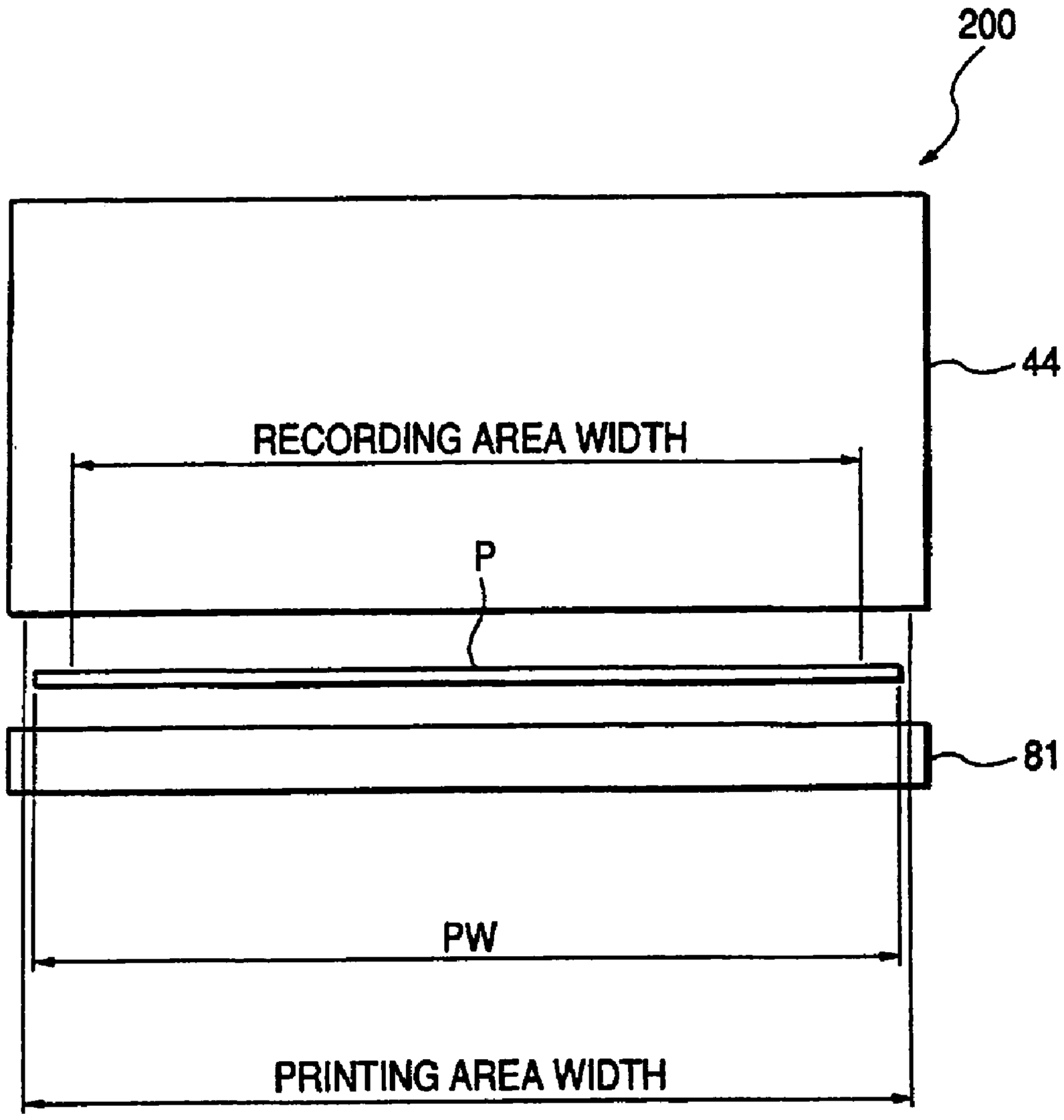


FIG. 3

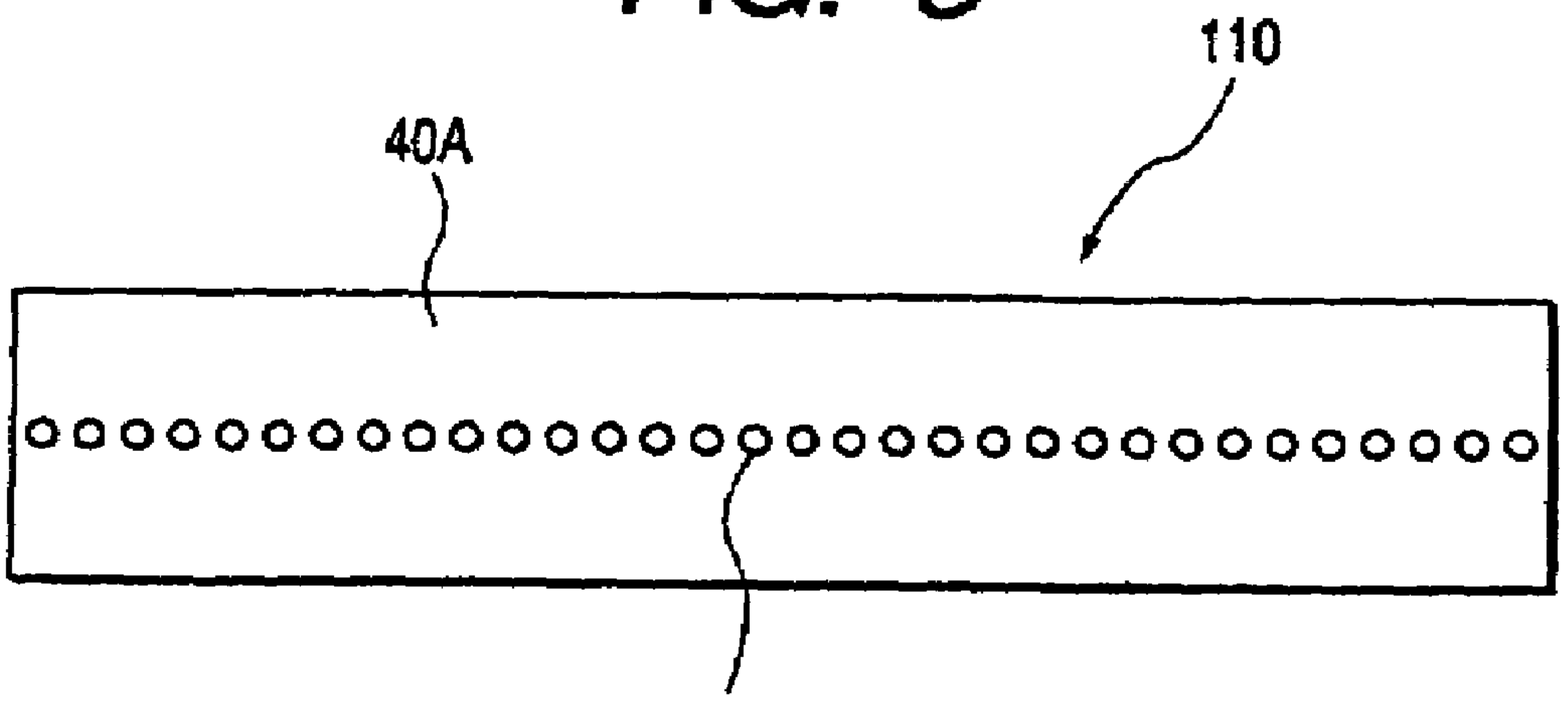


FIG. 4

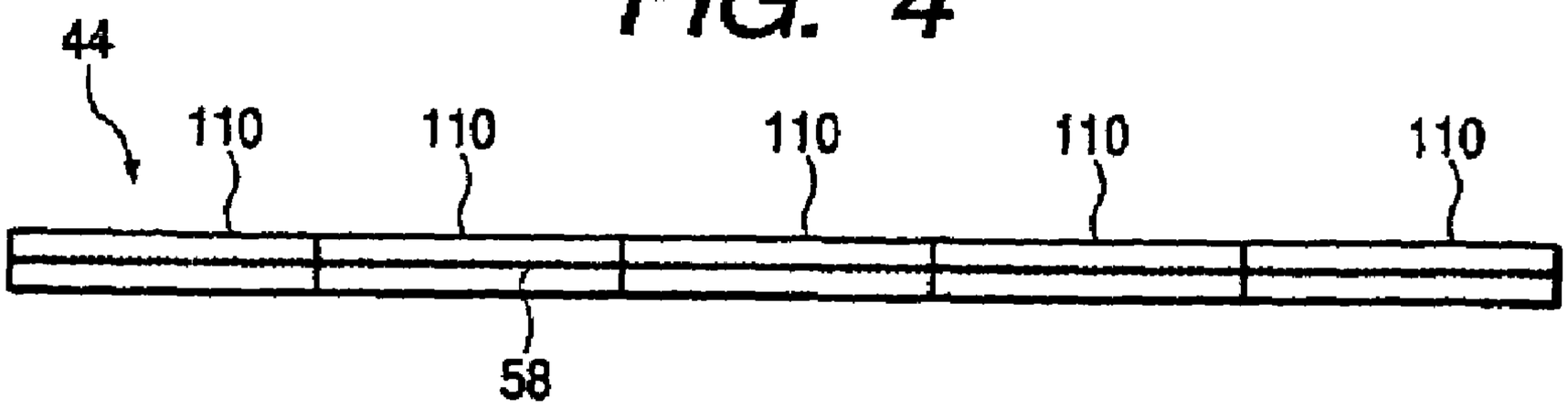


FIG. 5

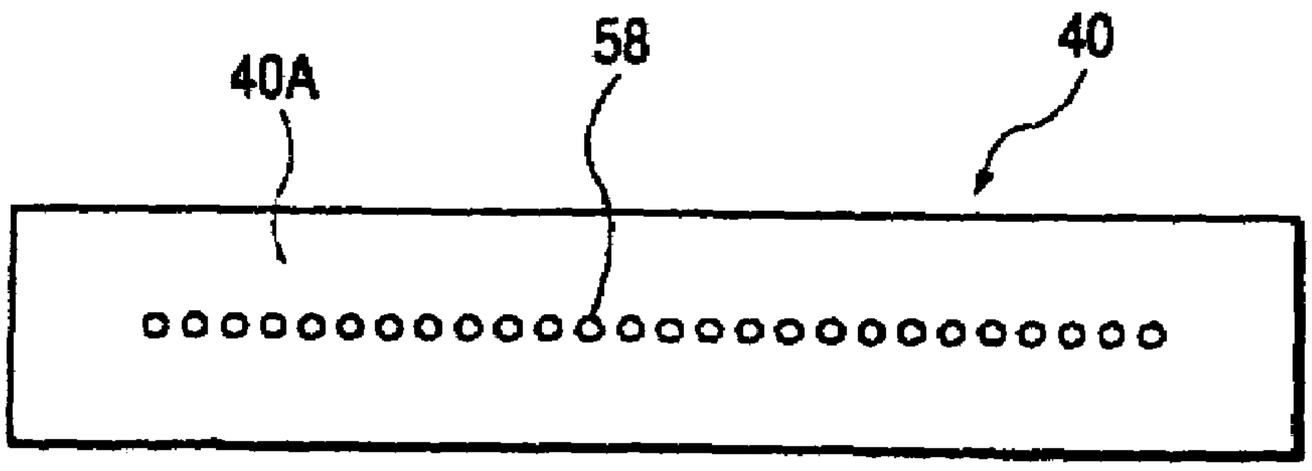


FIG. 6

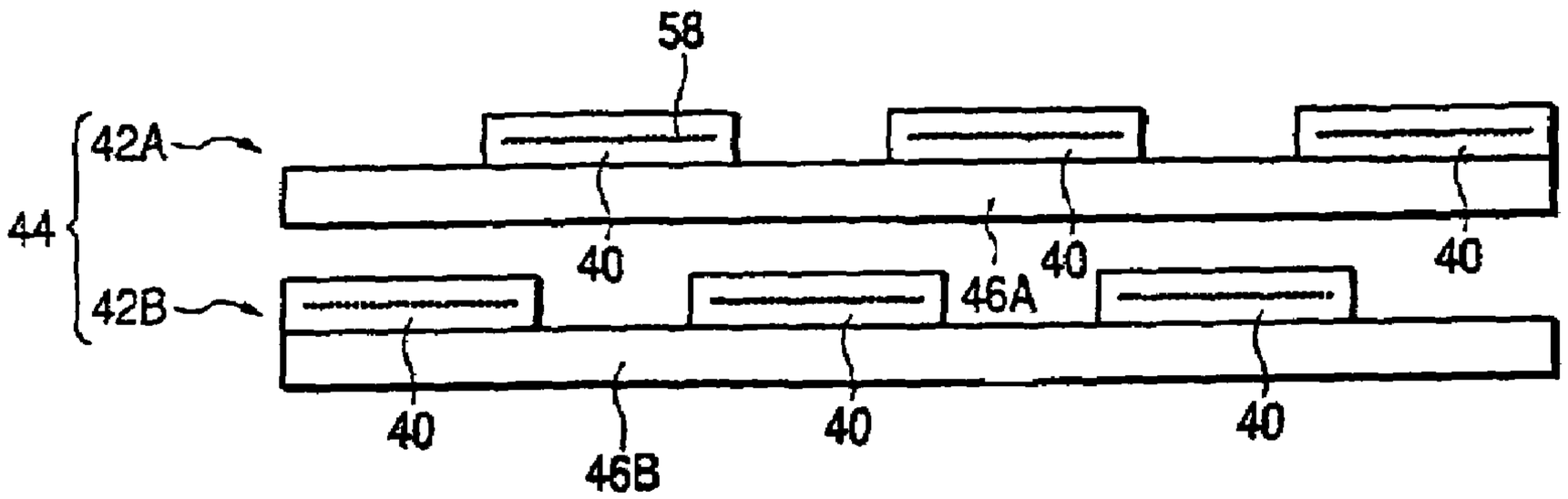


FIG. 7

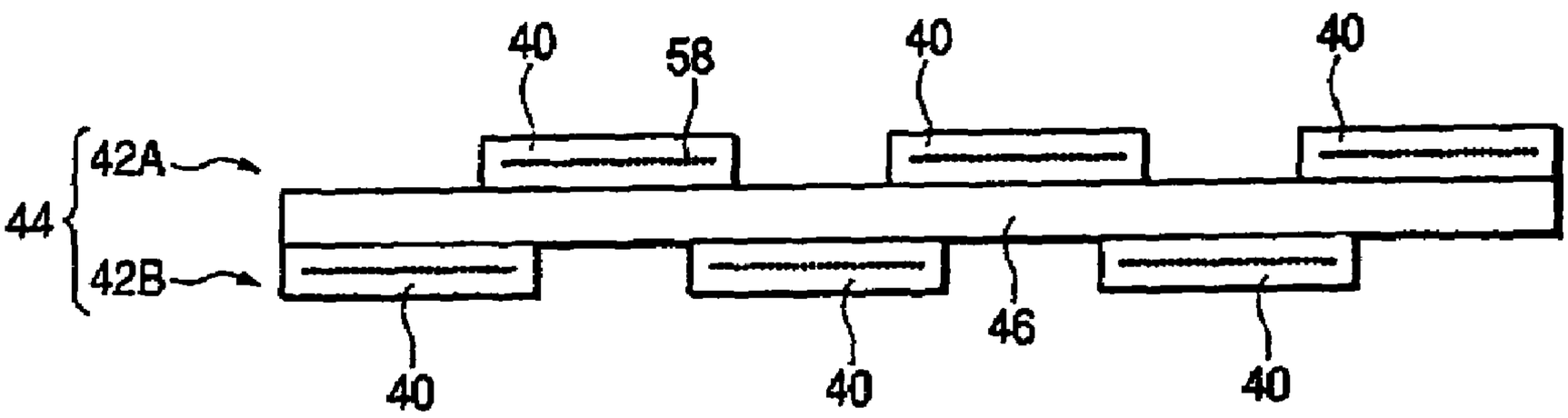


FIG. 8

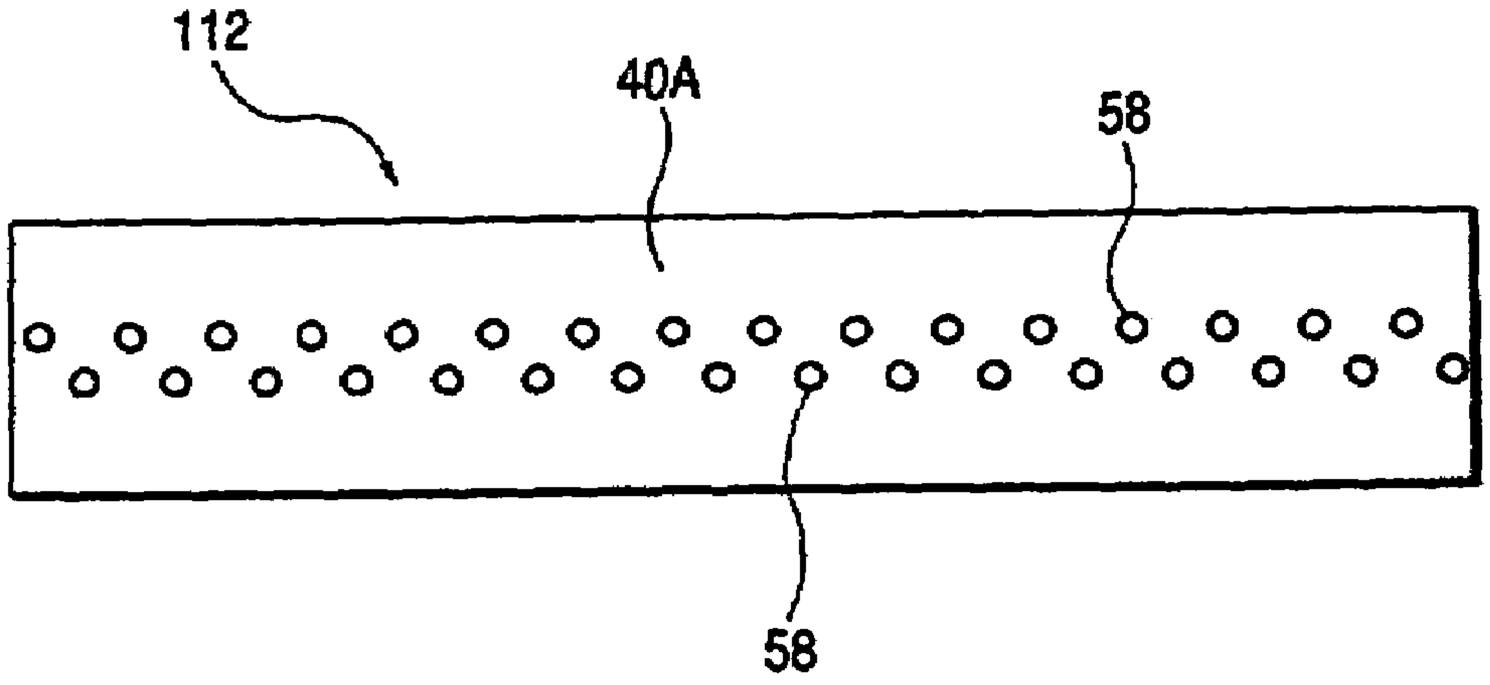


FIG. 9

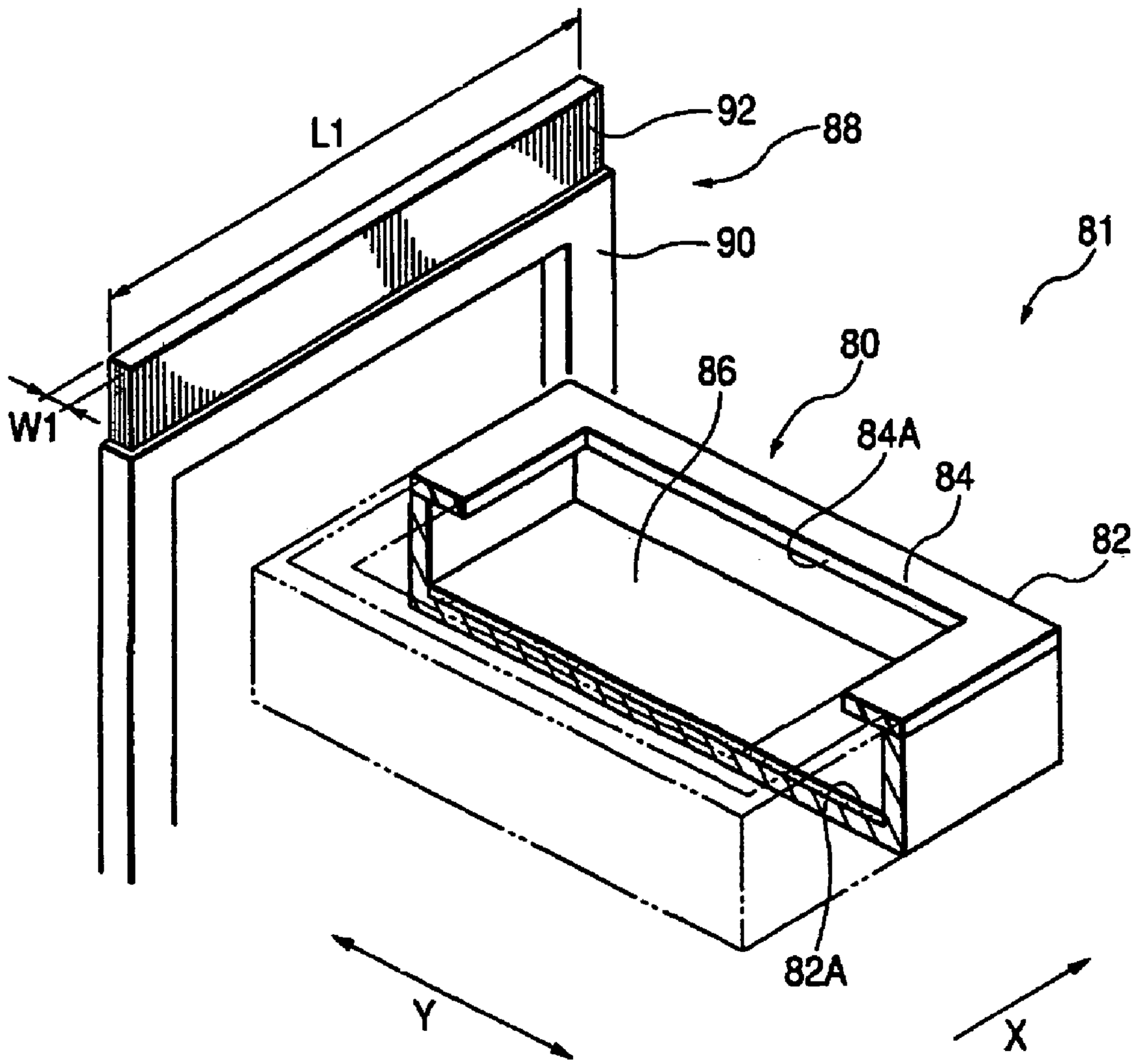


FIG. 10C

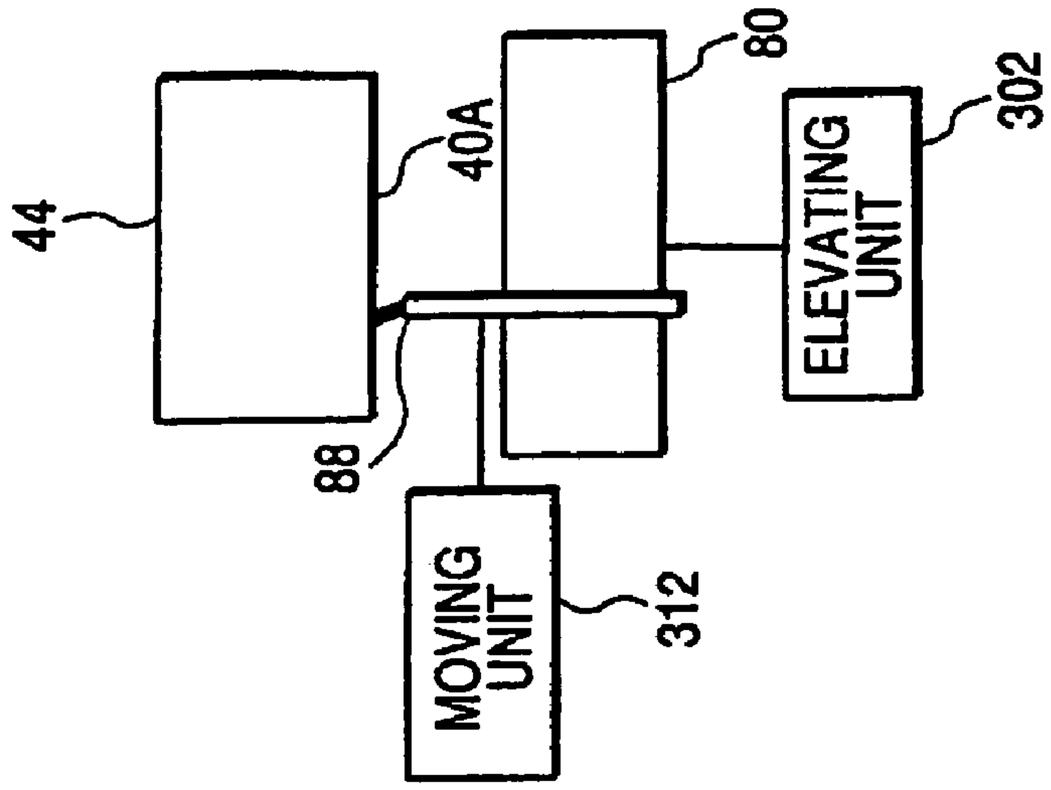


FIG. 10B

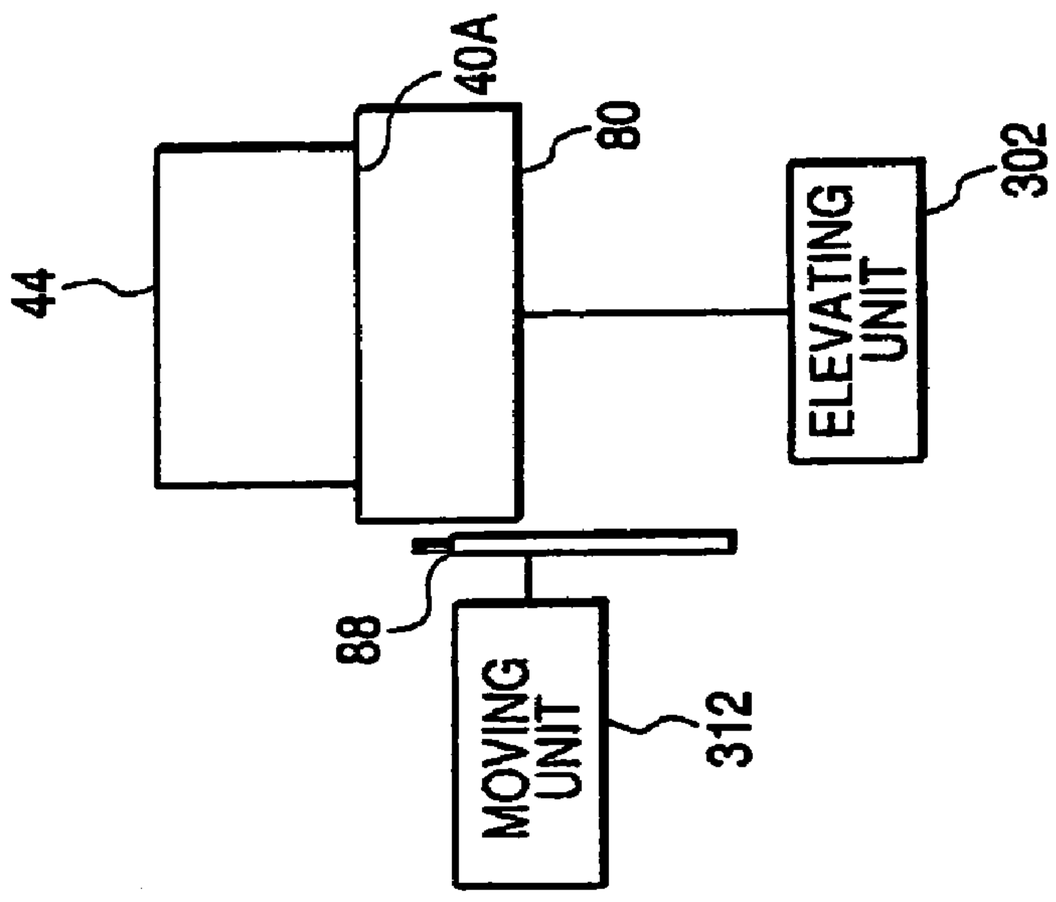


FIG. 10A

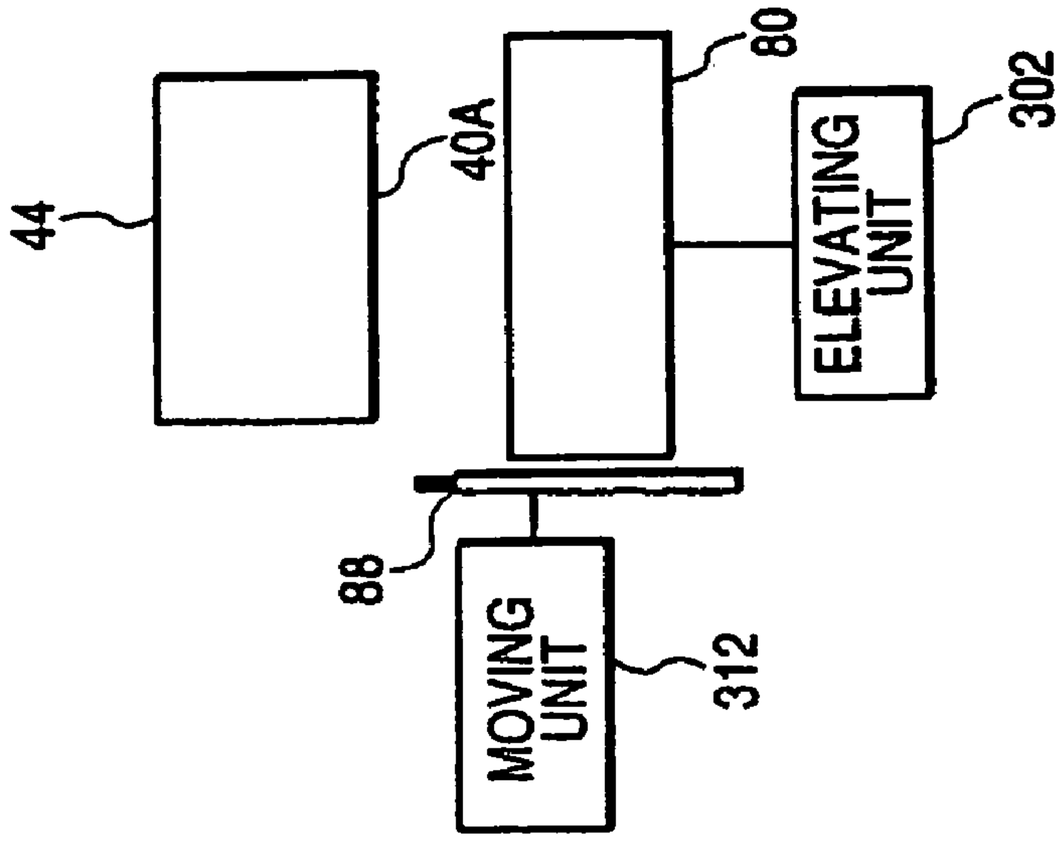


FIG. 11

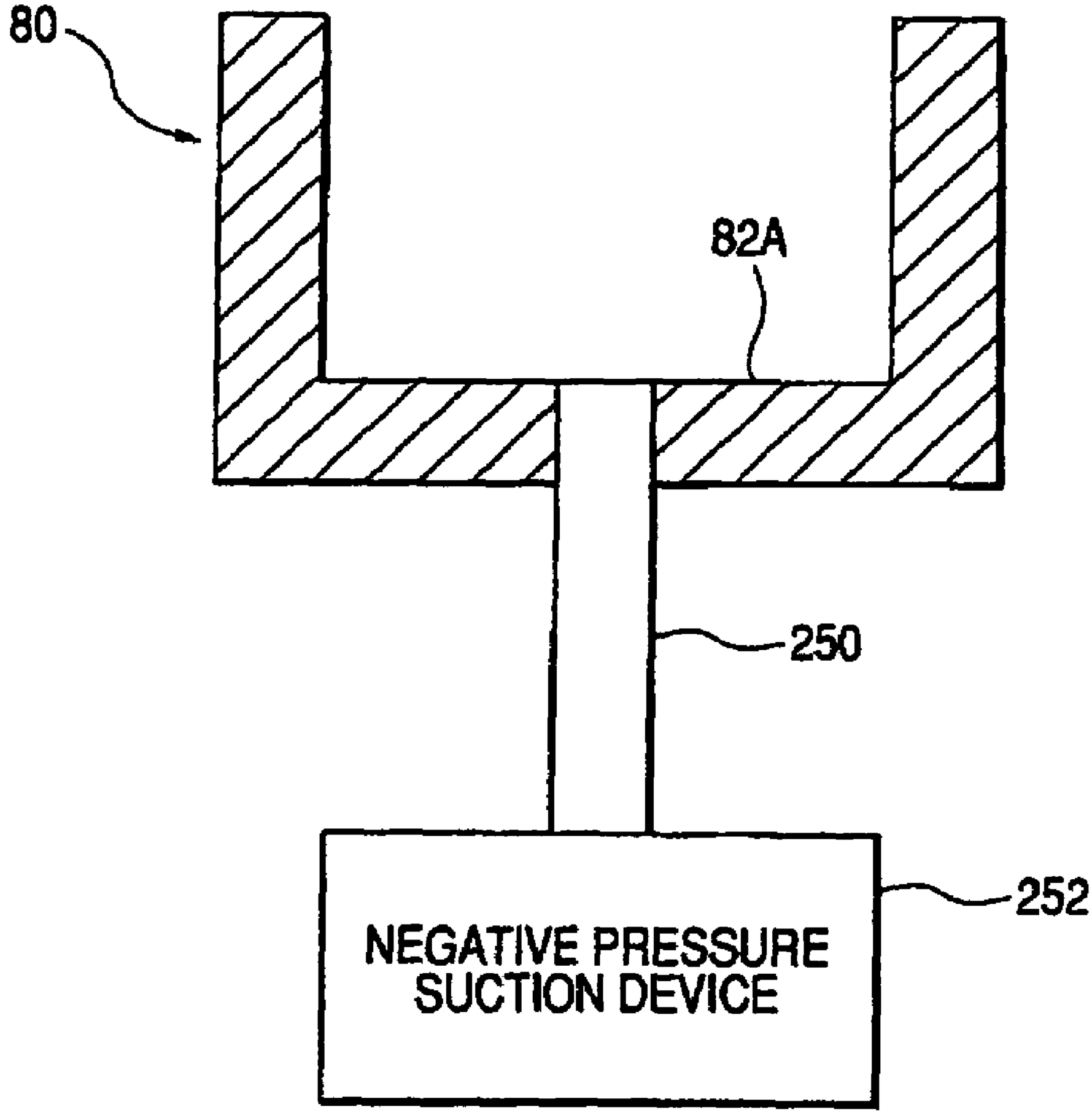
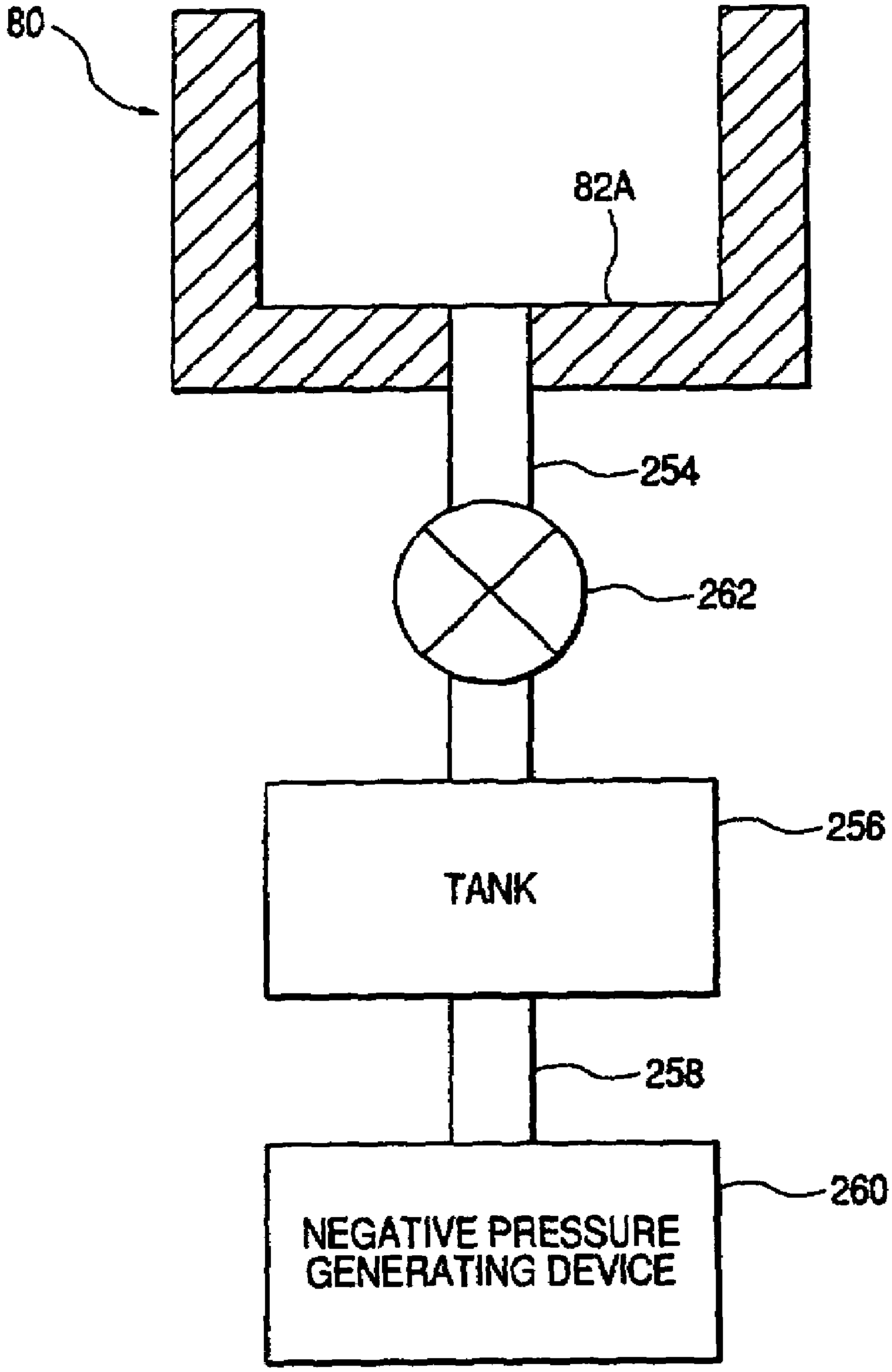


FIG. 12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82A
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262
TANK
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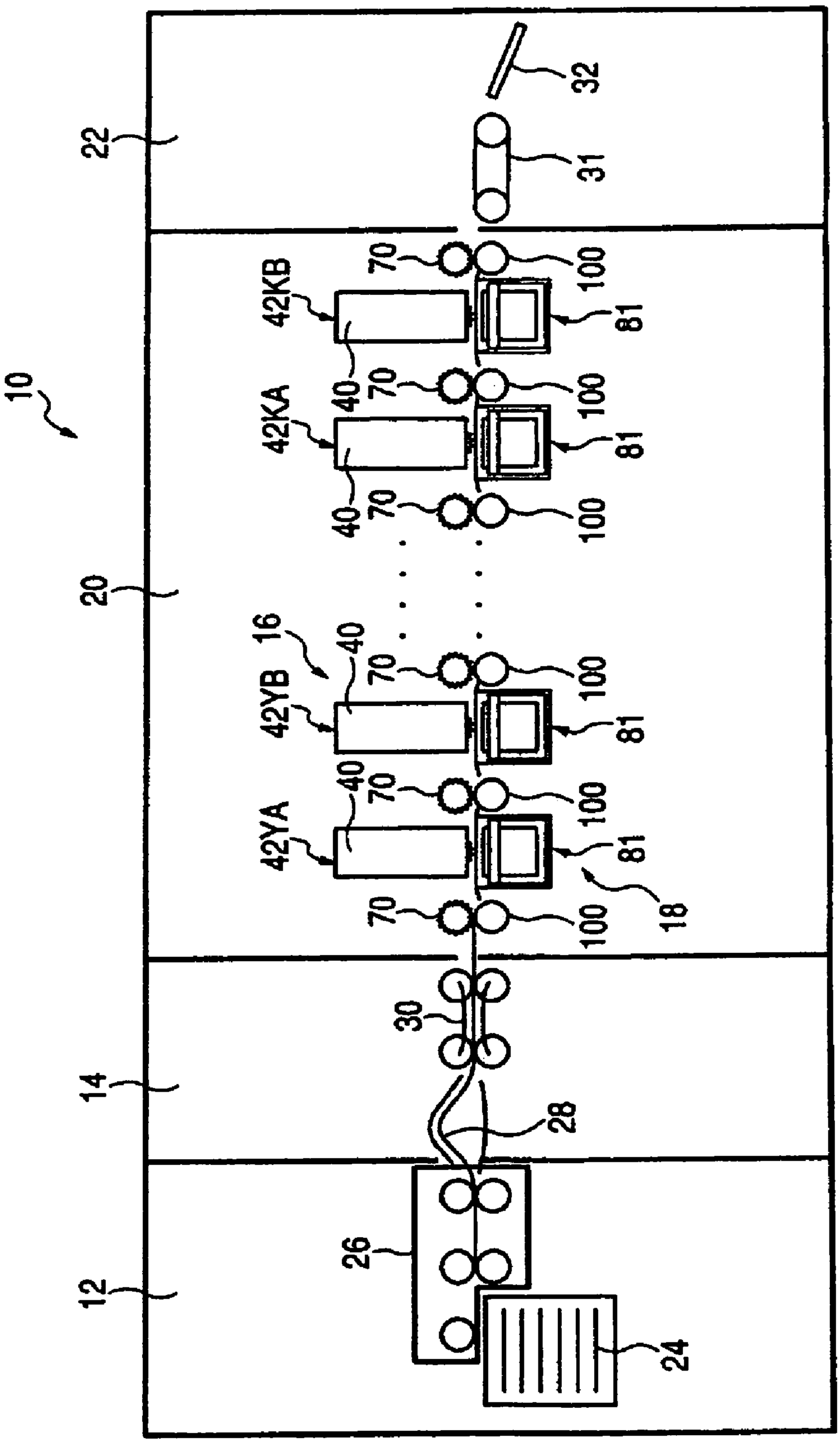
258
NEGATIVE PRESSURE GENERATING DEVICE
260

FIG. 13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14
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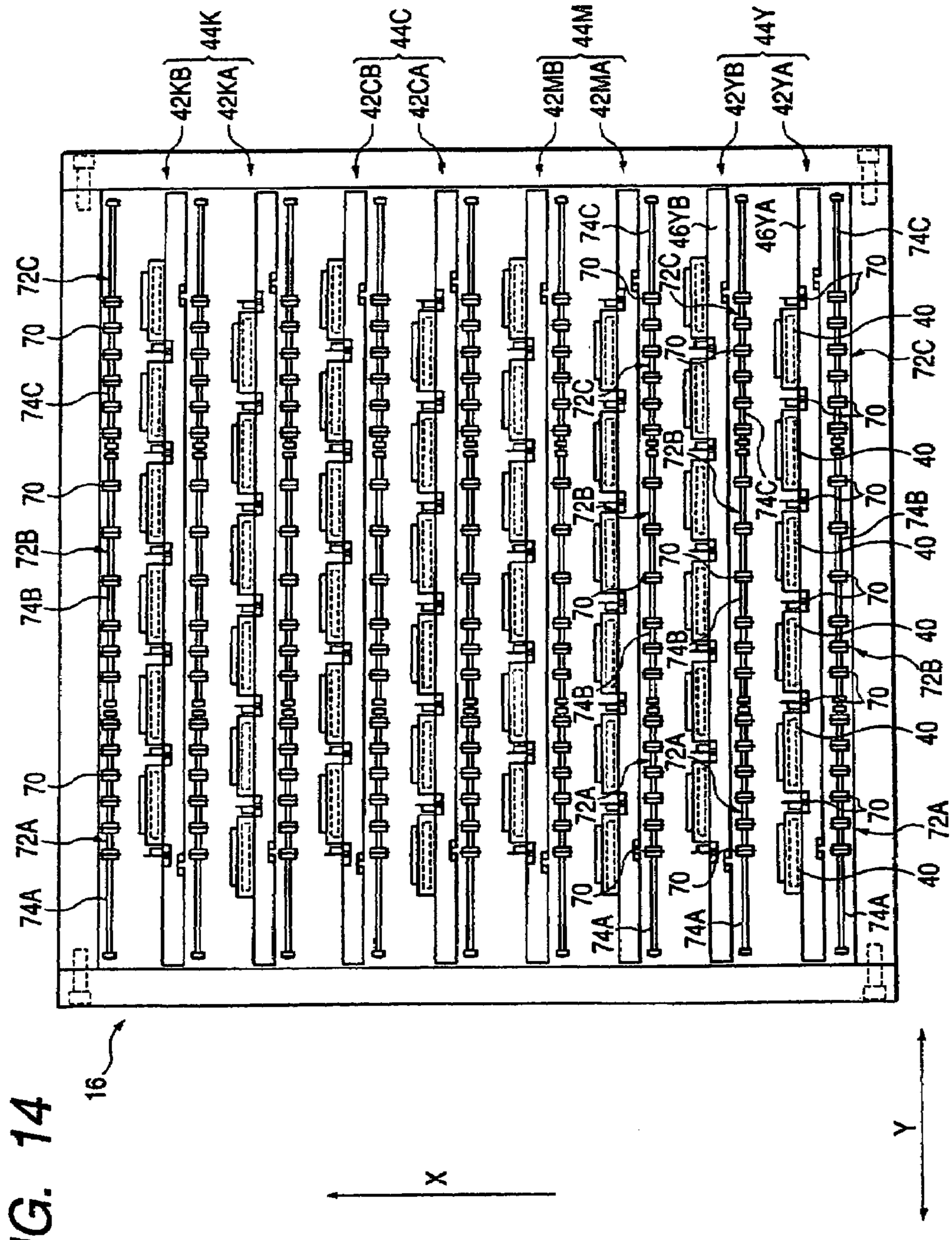
26
12
24


44K
42KB
42KA
44C
42CB
42CA
44M
42MB
42MA
44Y
42YB
42YA
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70
74C
72B
74B
72A
74A
46YB
46YA
40
16
x
y

FIG. 14

FIG. 15

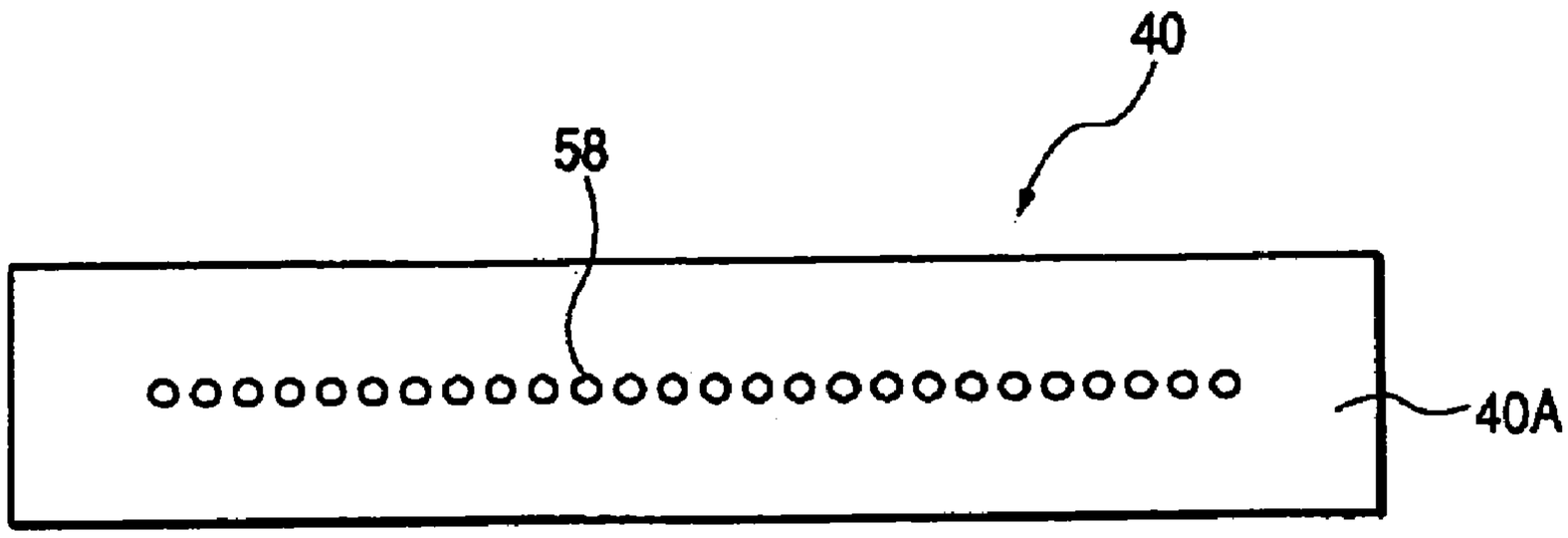


FIG. 16

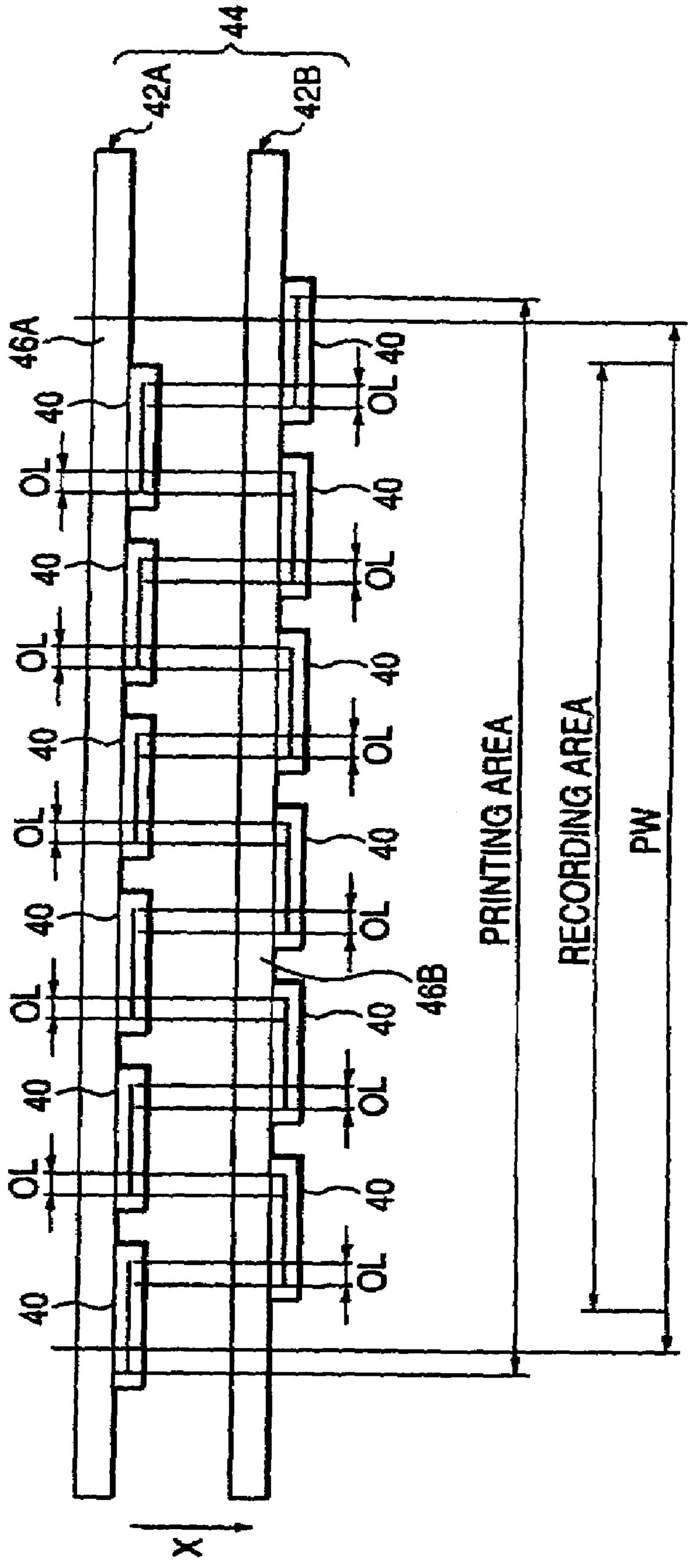


FIG. 17

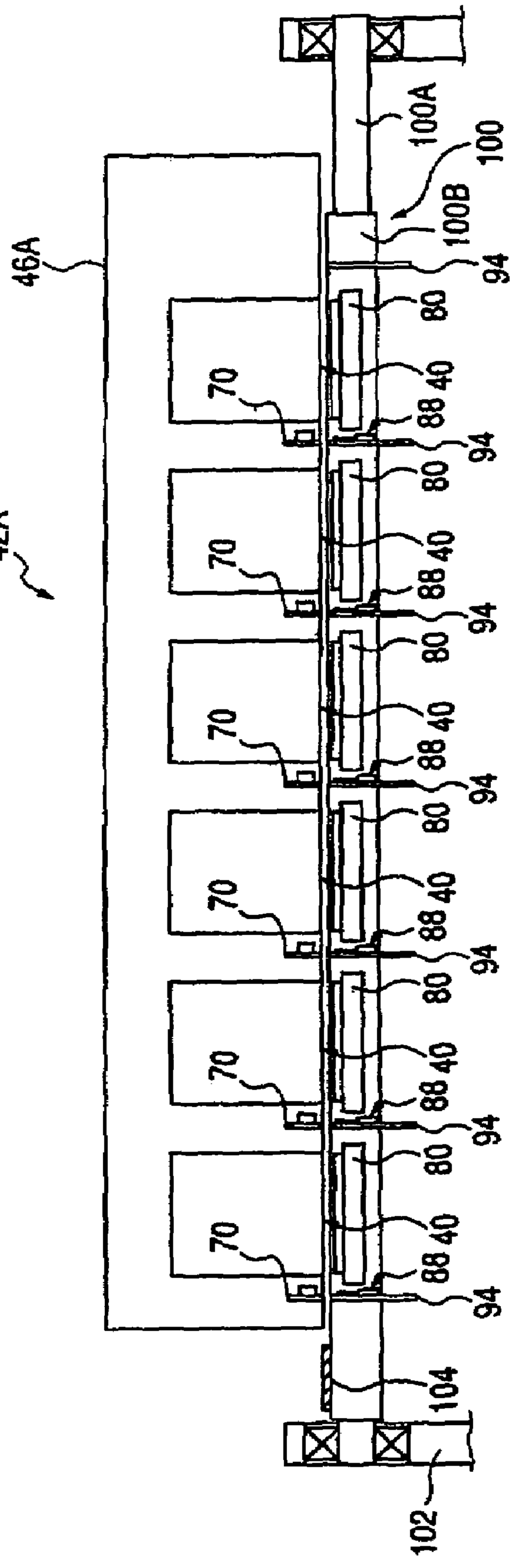
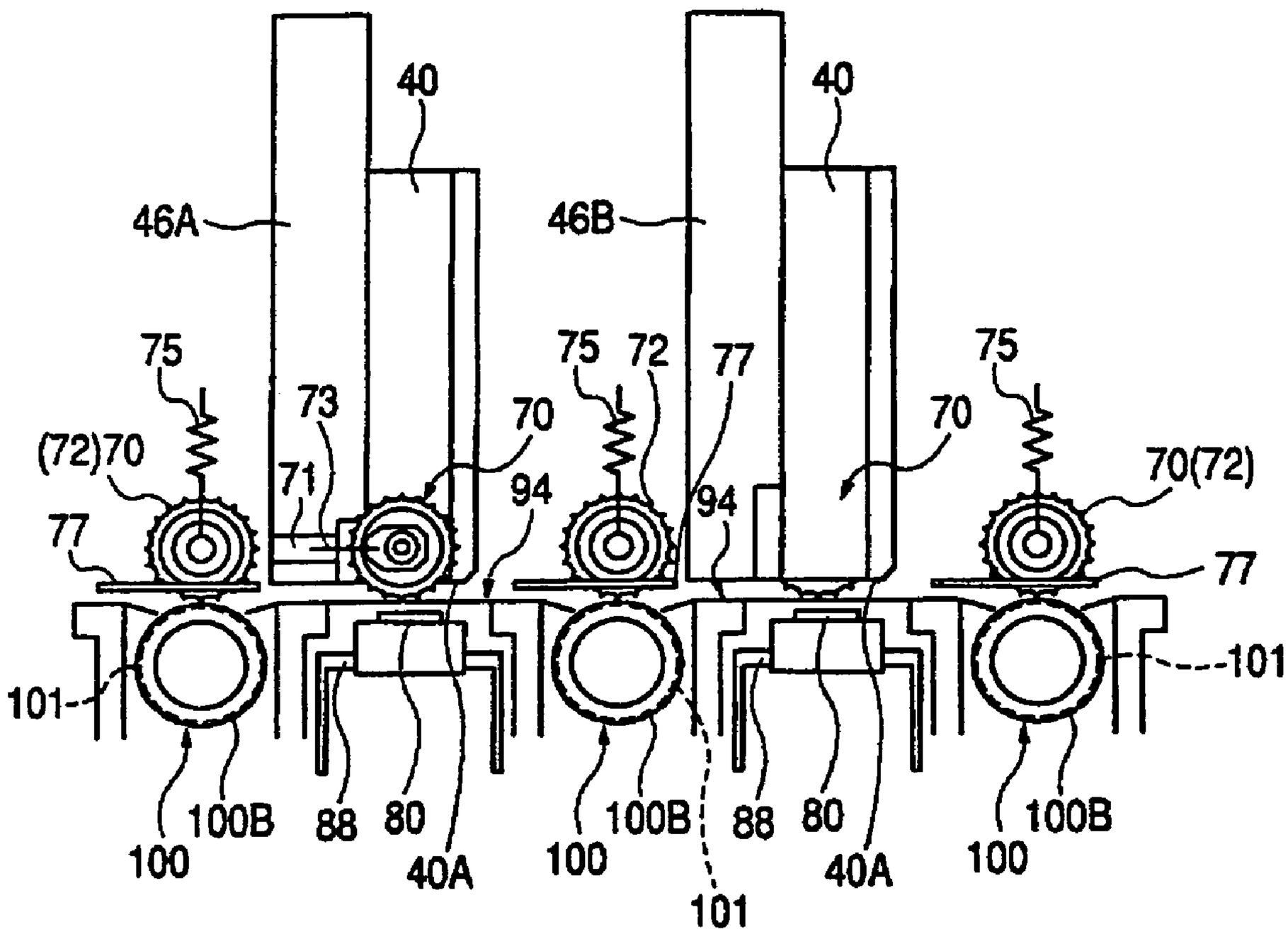


FIG. 18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46A
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(72)70
71
94
94
70(72)
77
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101
101
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100B
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40A
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100B
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FIG. 19A

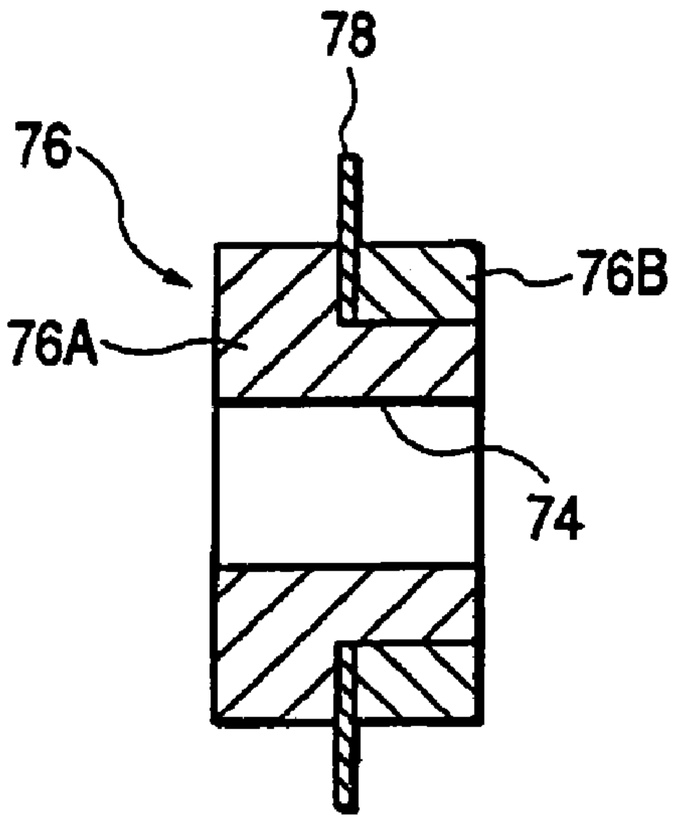


FIG. 19B

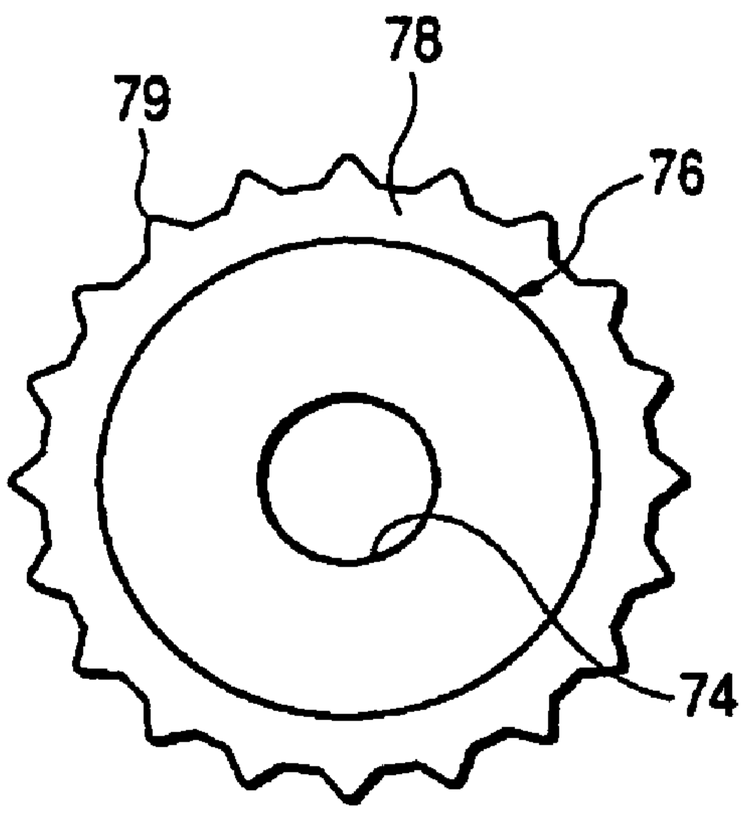
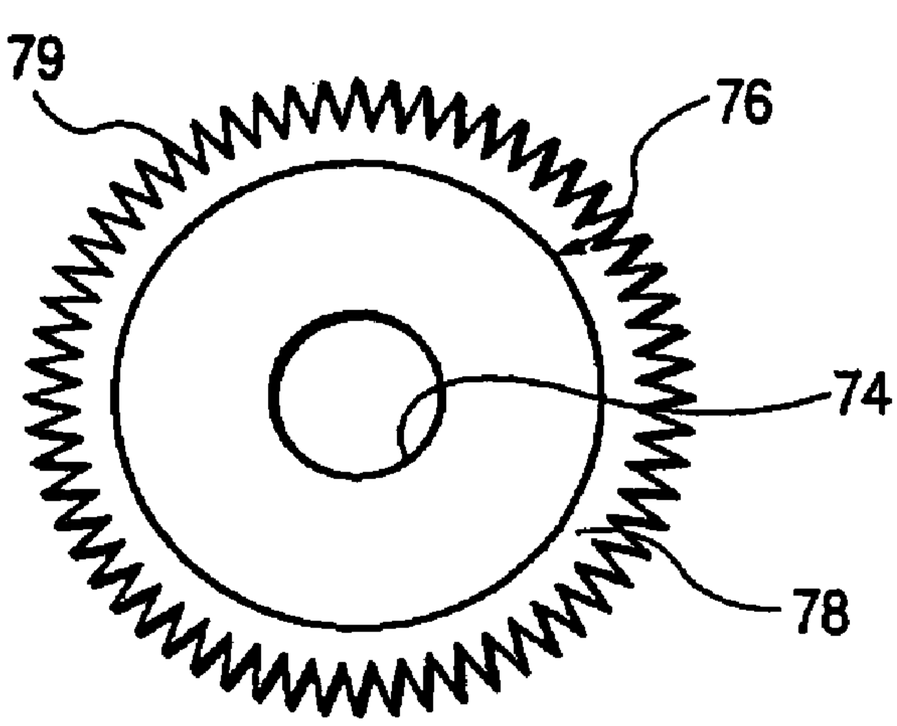


FIG. 19C



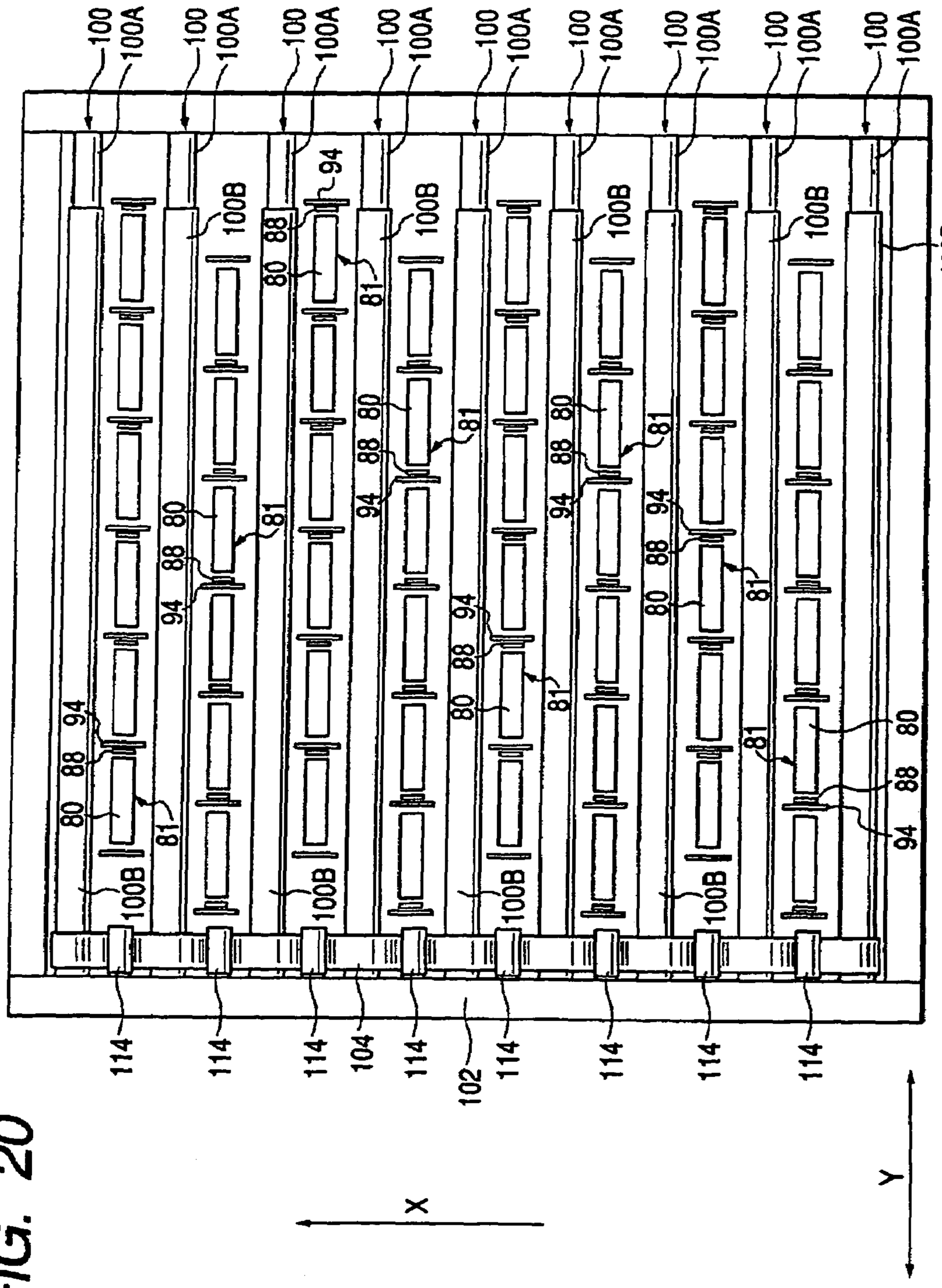


FIG. 20

FIG. 21

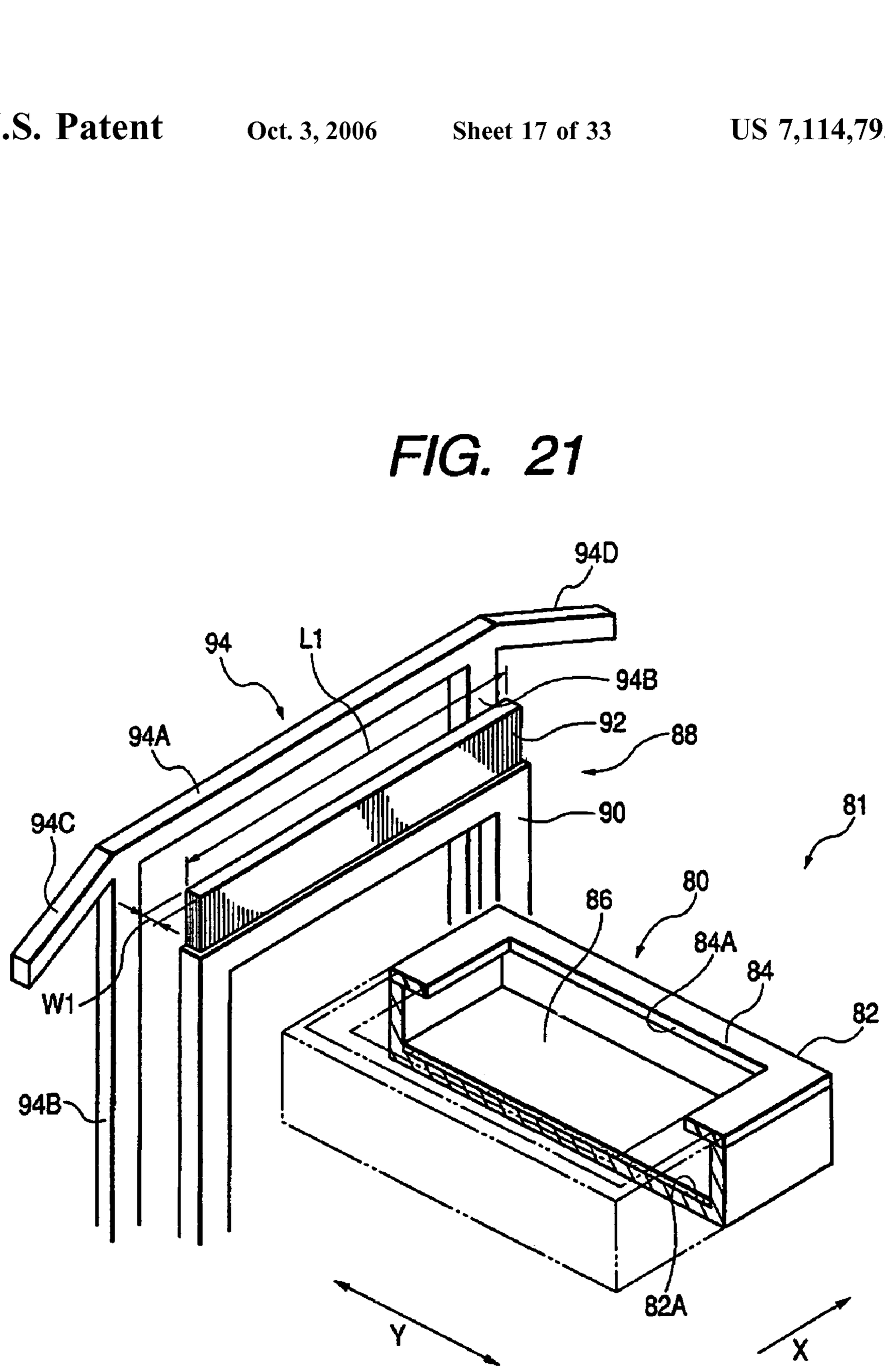


FIG. 22

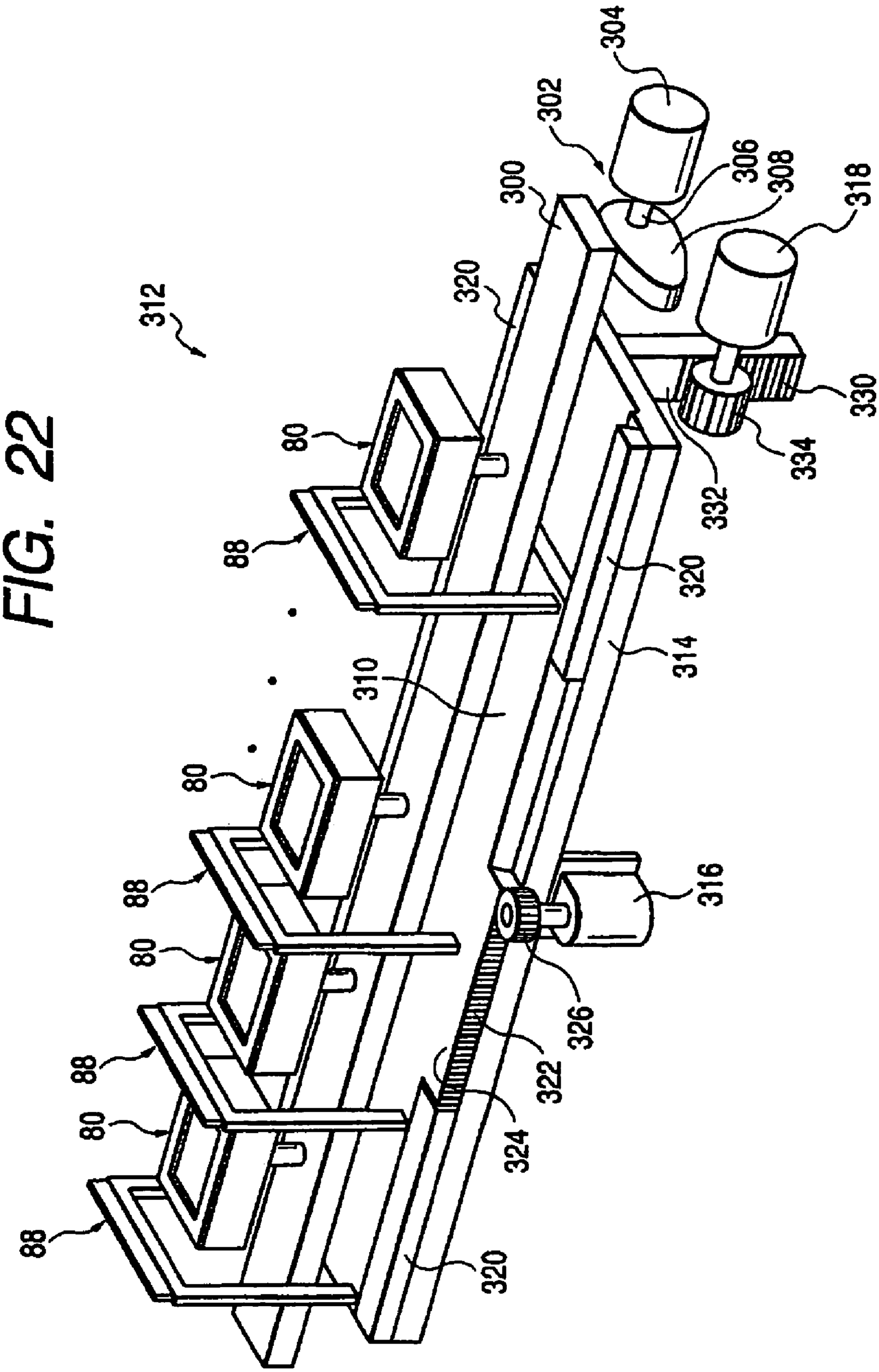

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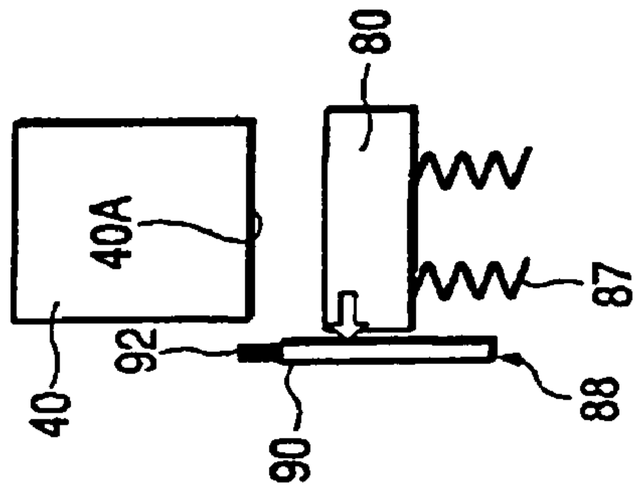
FIG. 23D



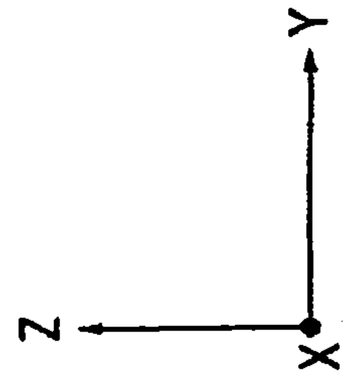


FIG. 23C

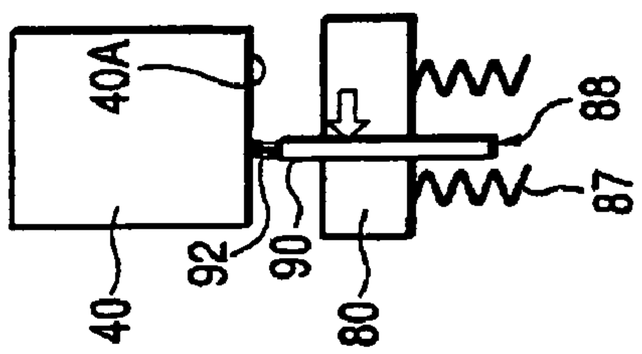


FIG. 23G

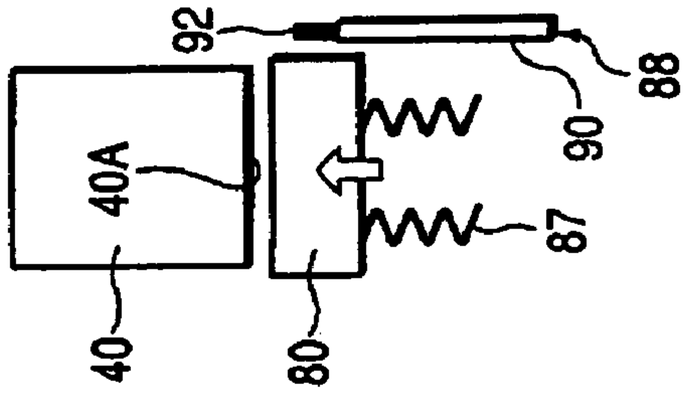


FIG. 23B

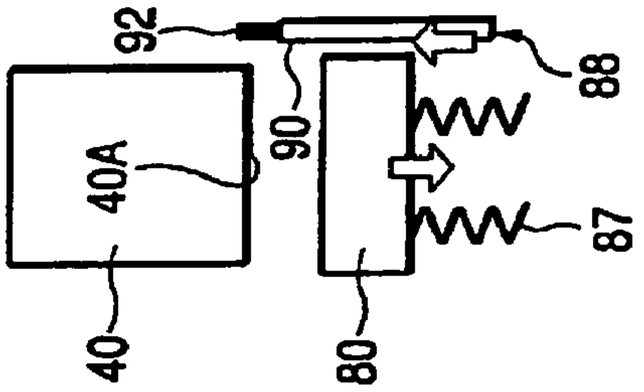


FIG. 23F

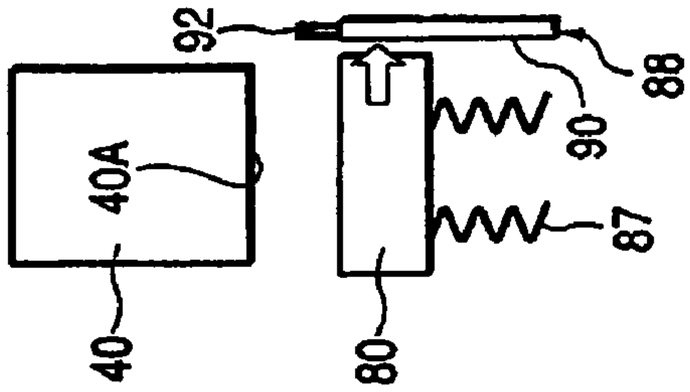


FIG. 23A

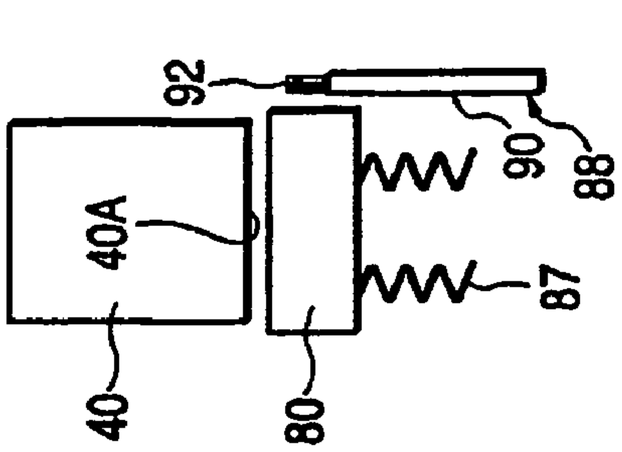
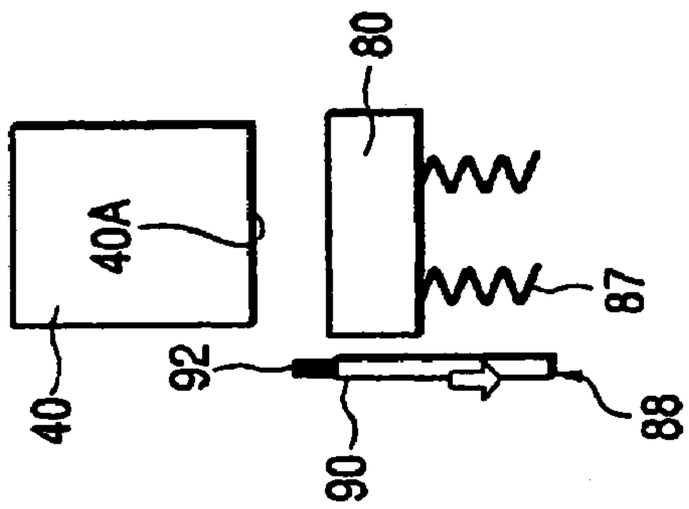


FIG. 23E



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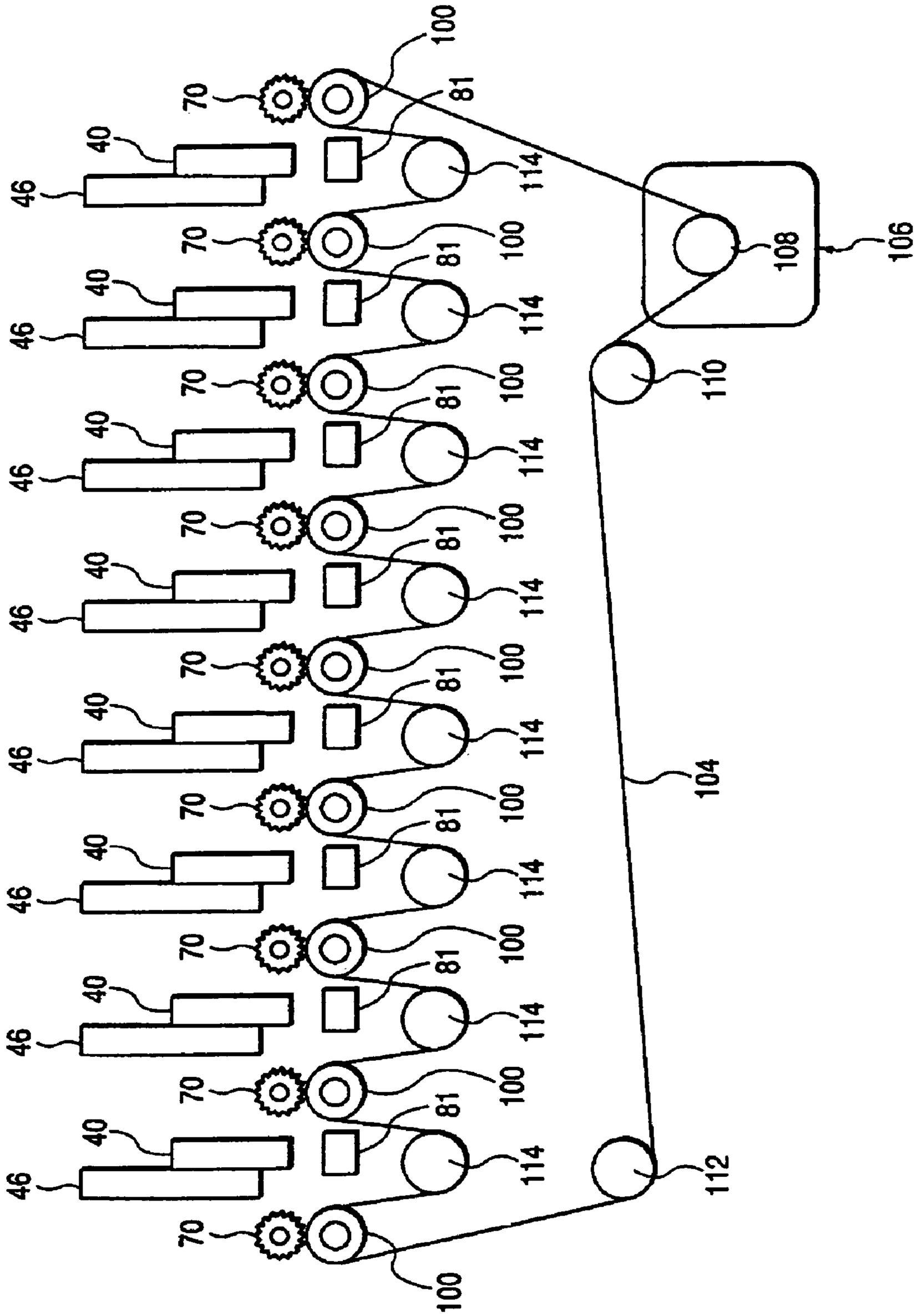
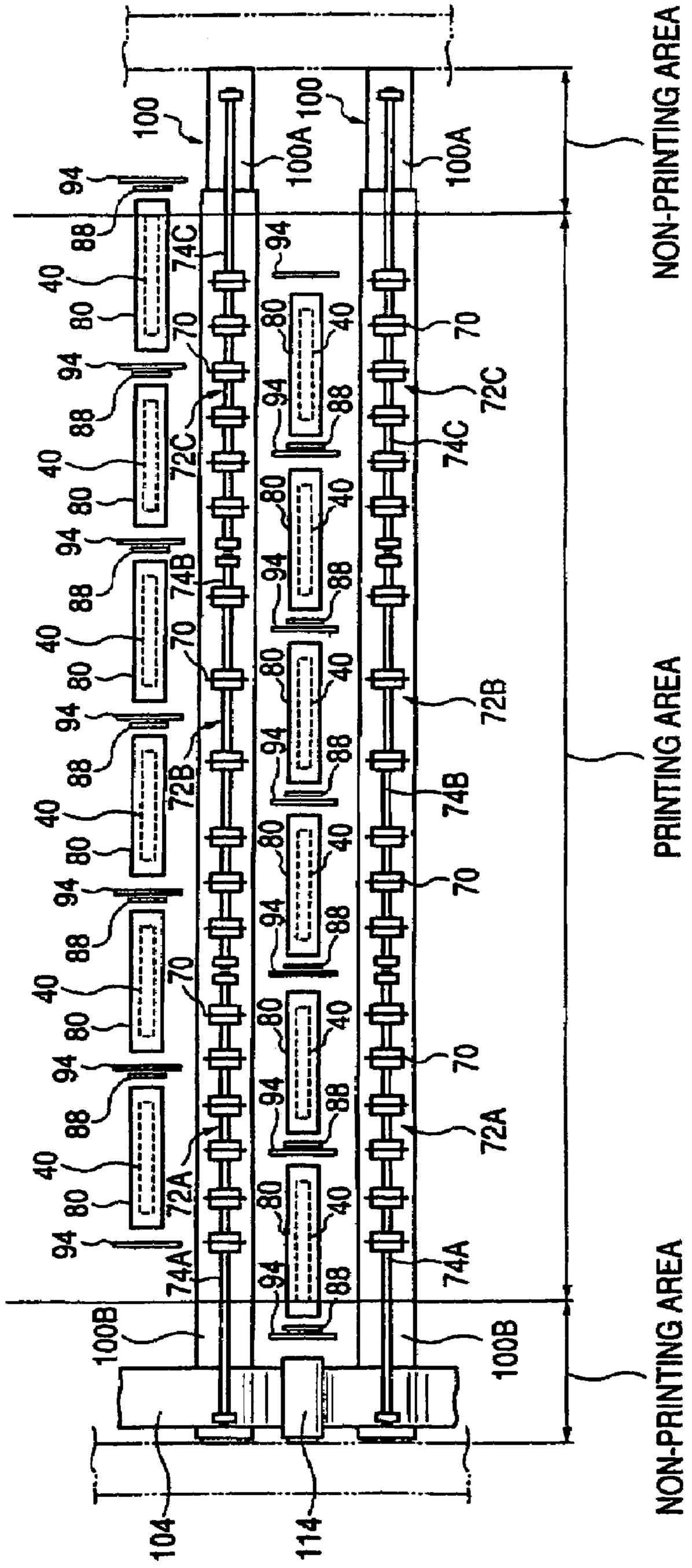


FIG. 25


NON-PRINTING AREA
PRINTING AREA
NON-PRINTING AREA
100
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72B
74A
72A
70
100B
104
114

FIG. 26A

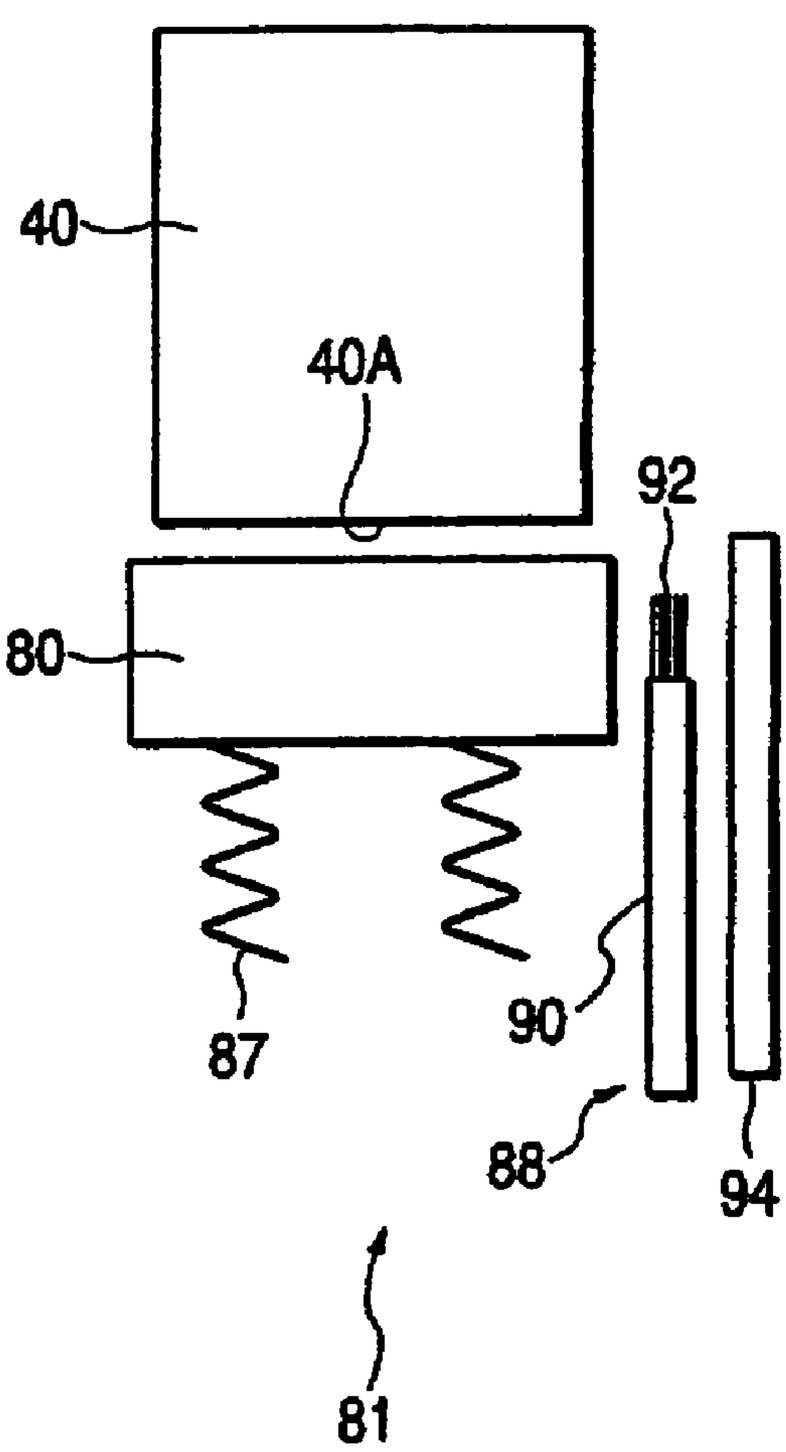


FIG. 26B

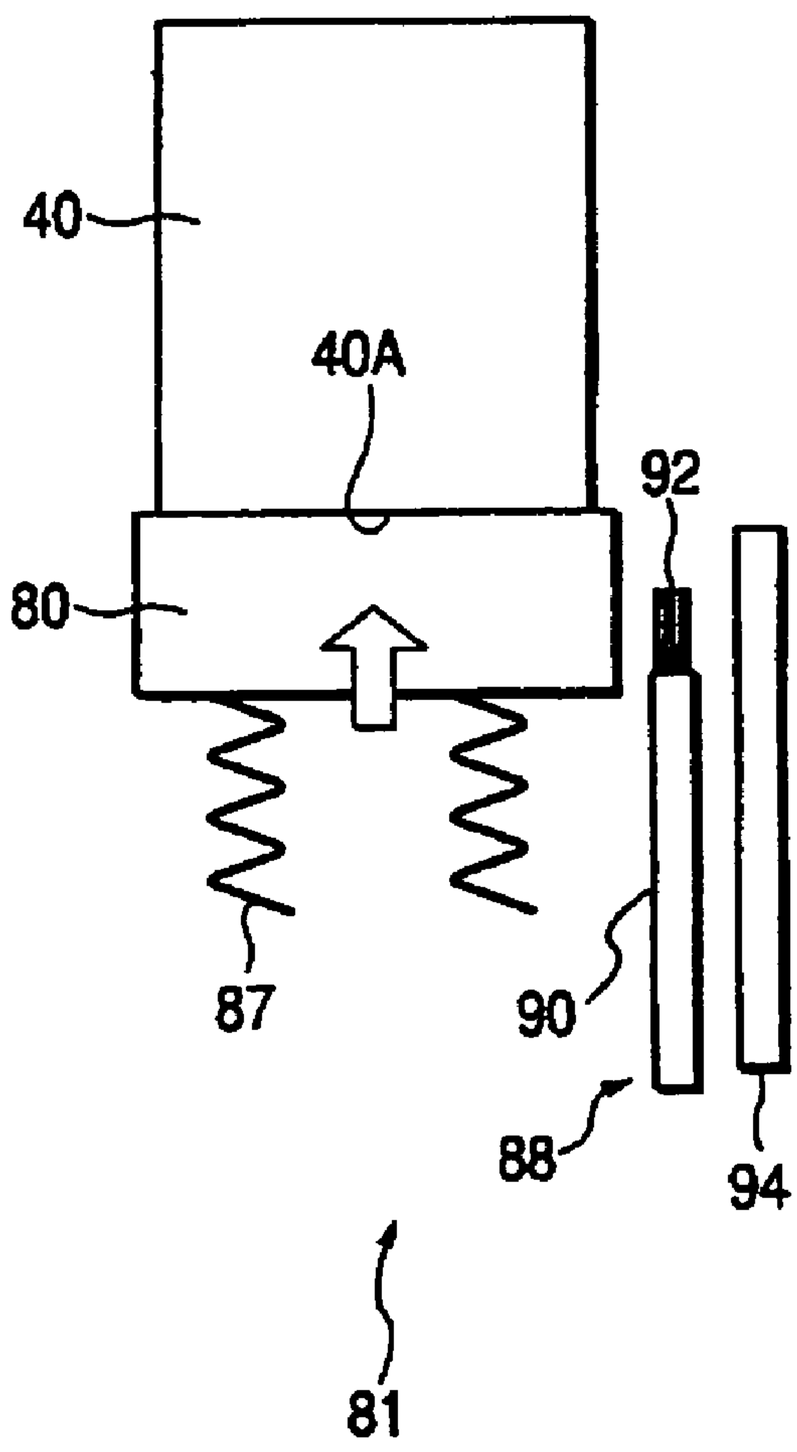


FIG. 27A

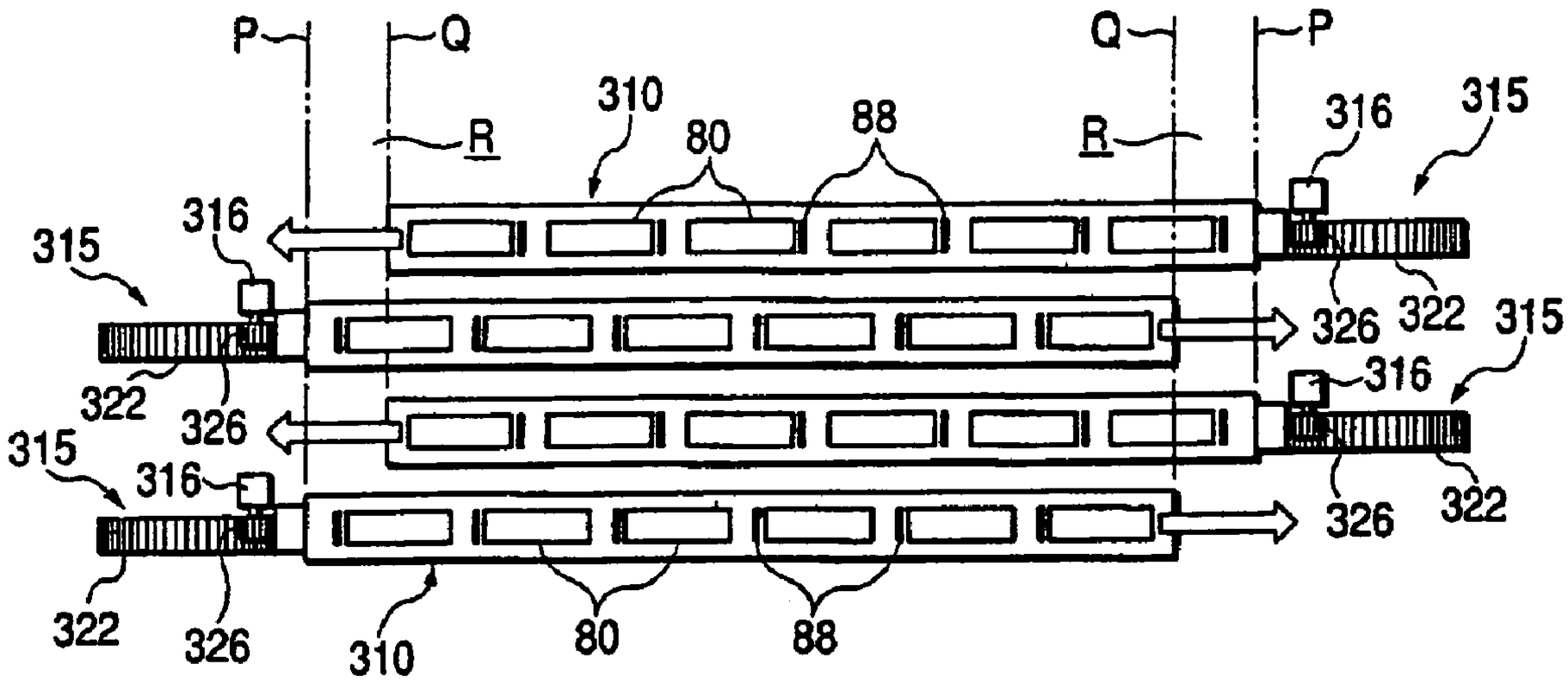


FIG. 27B

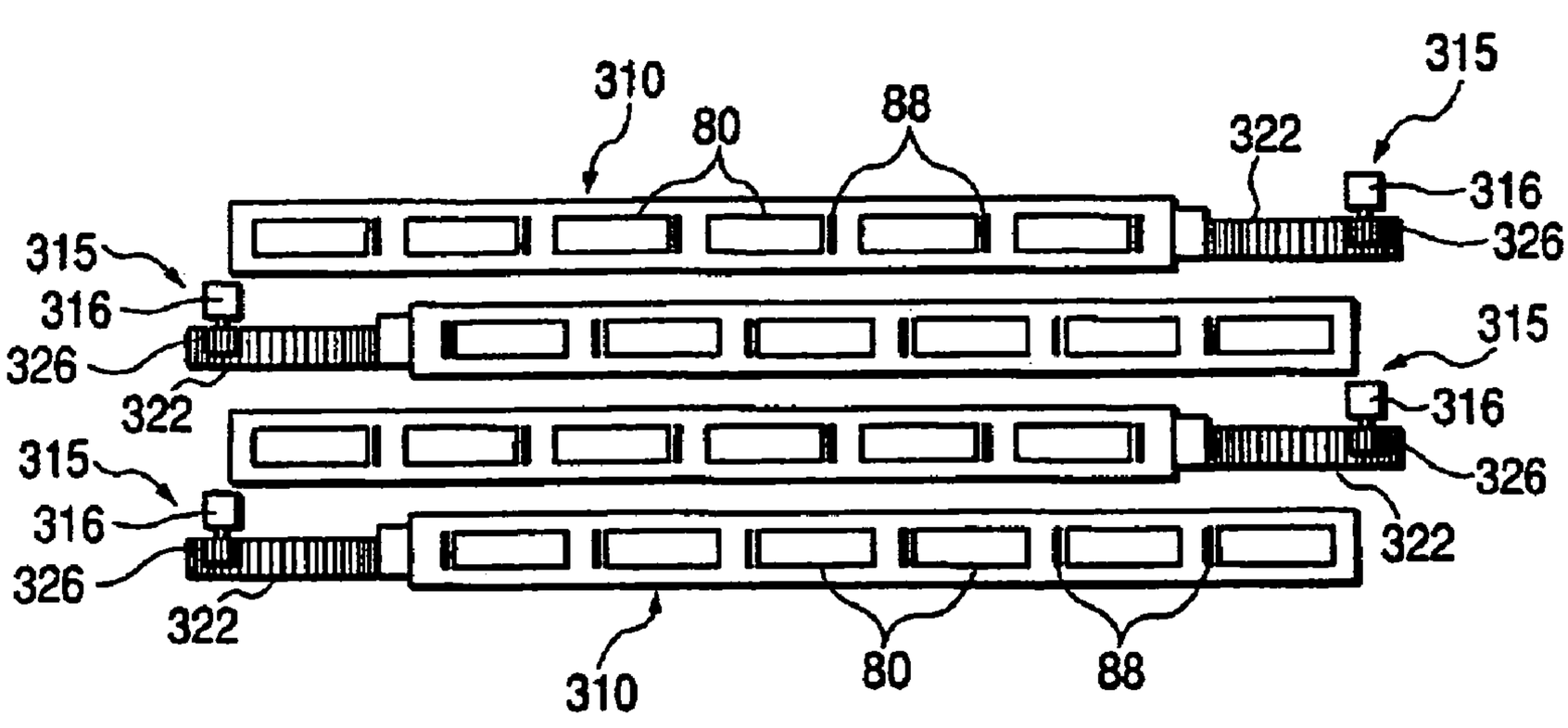


FIG. 28A

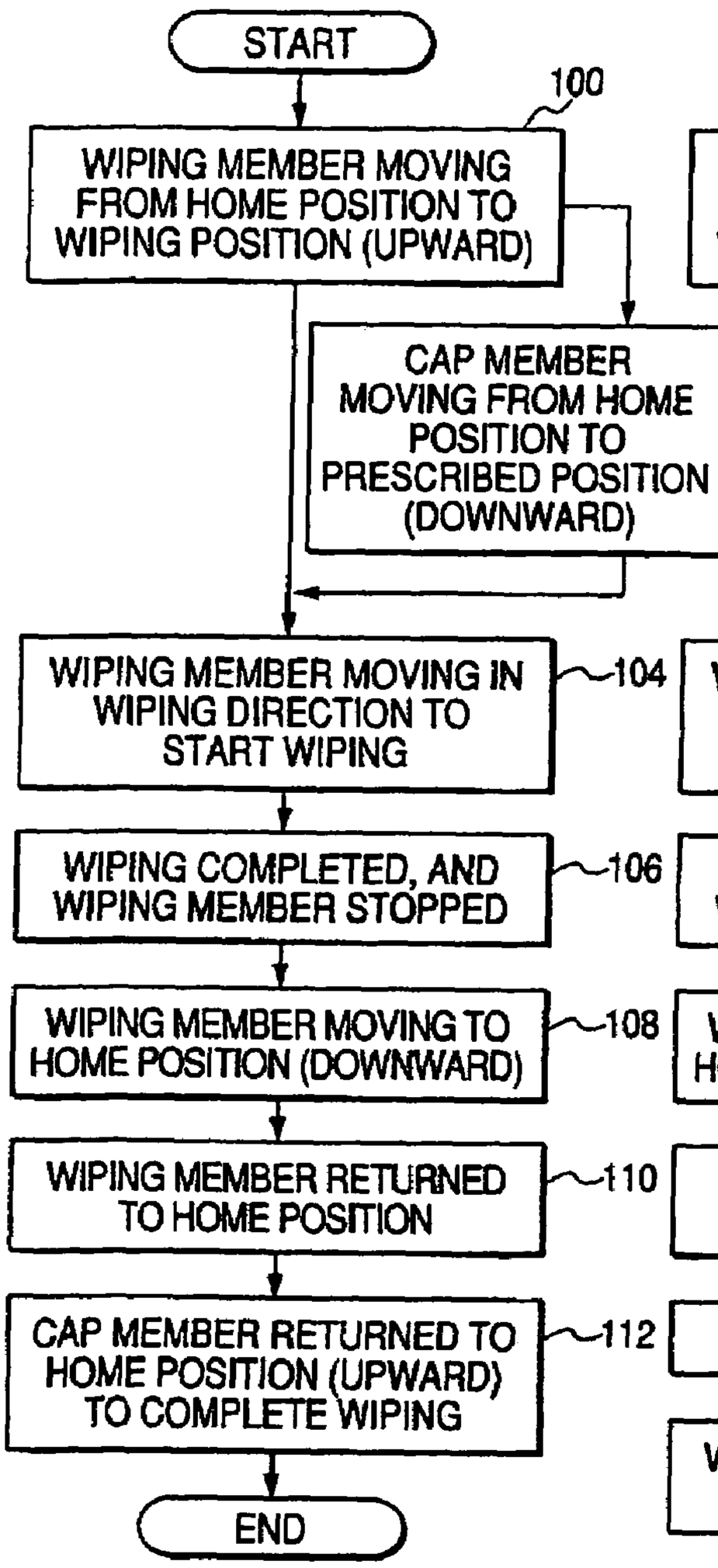


FIG. 28B

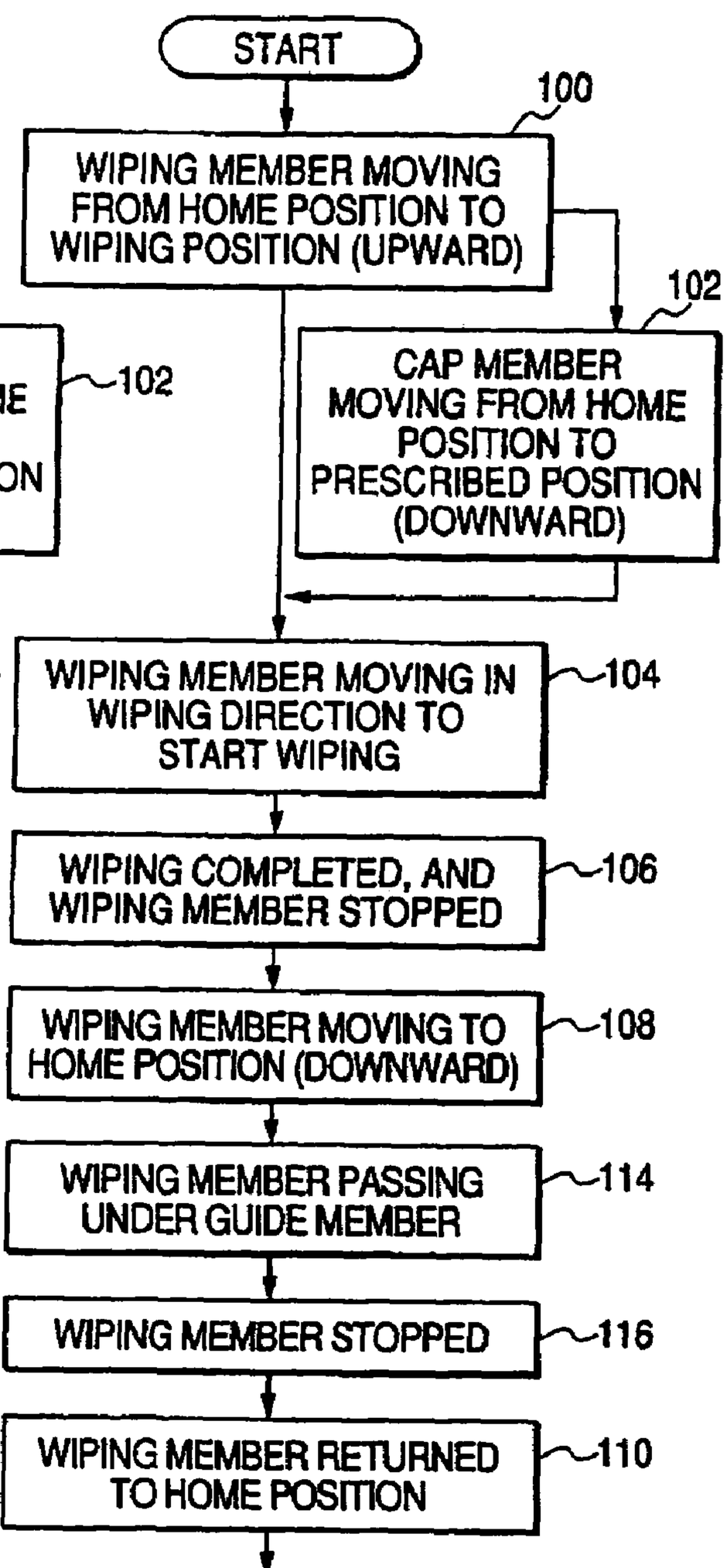


FIG. 29

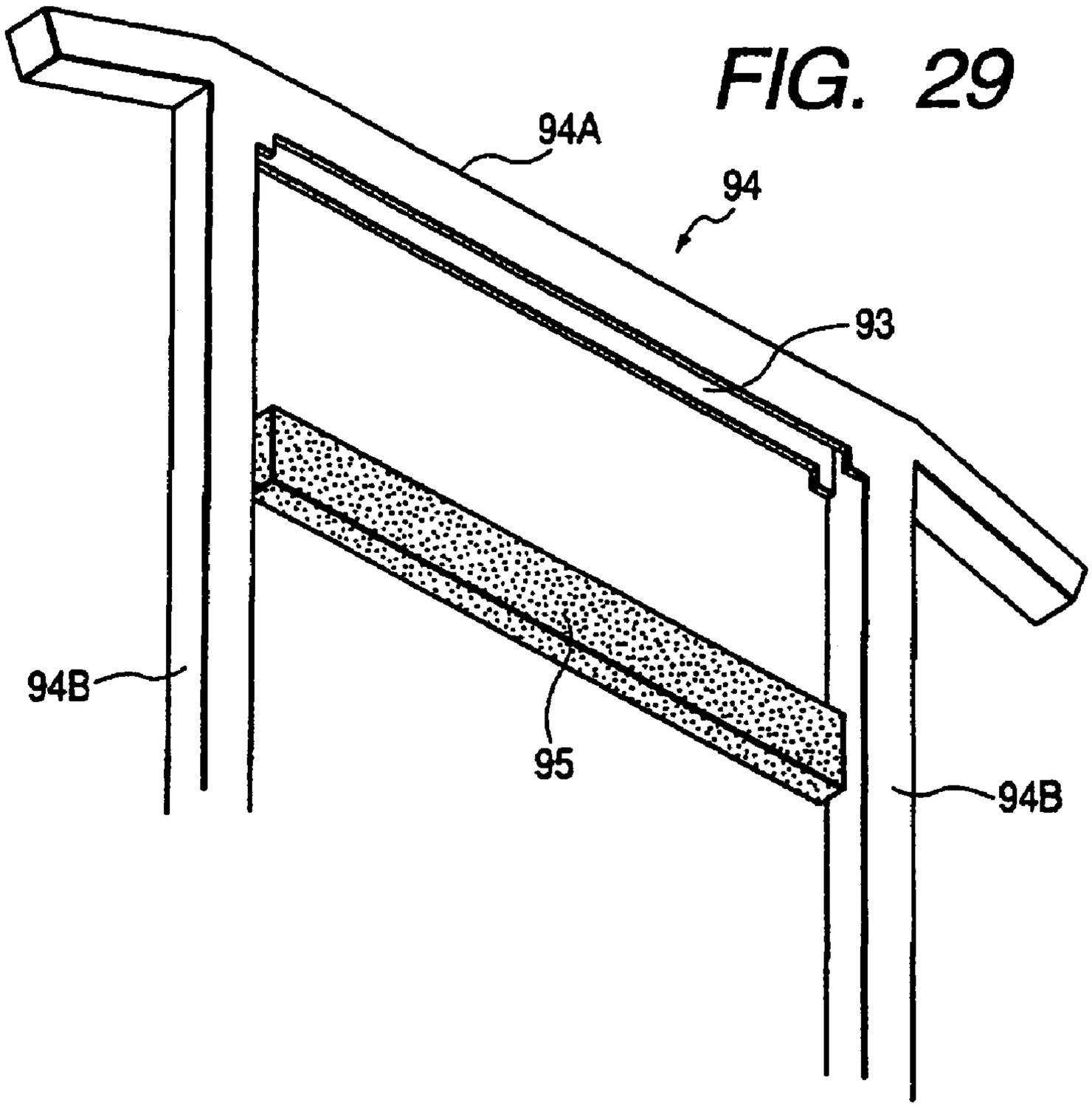
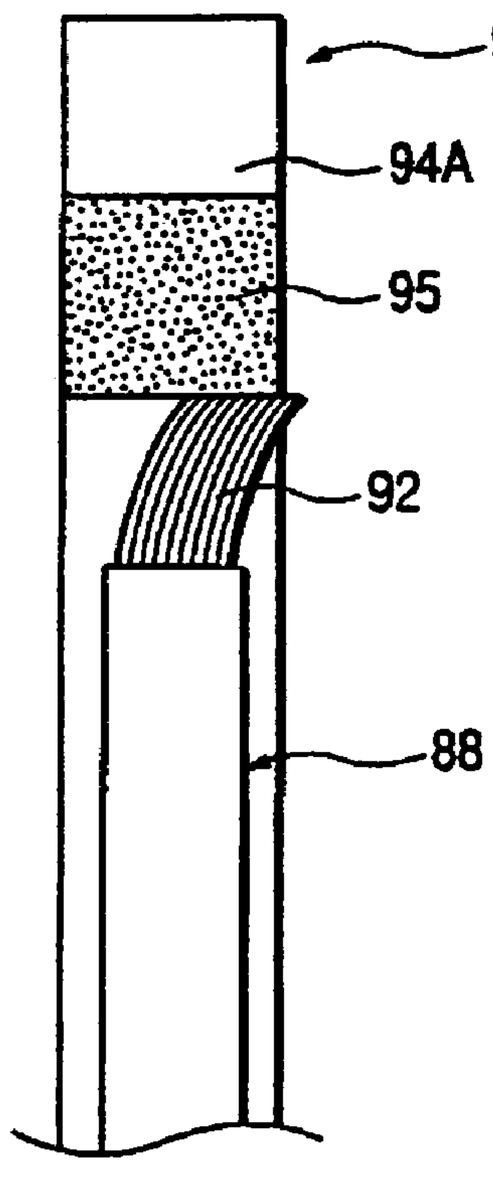


FIG. 30



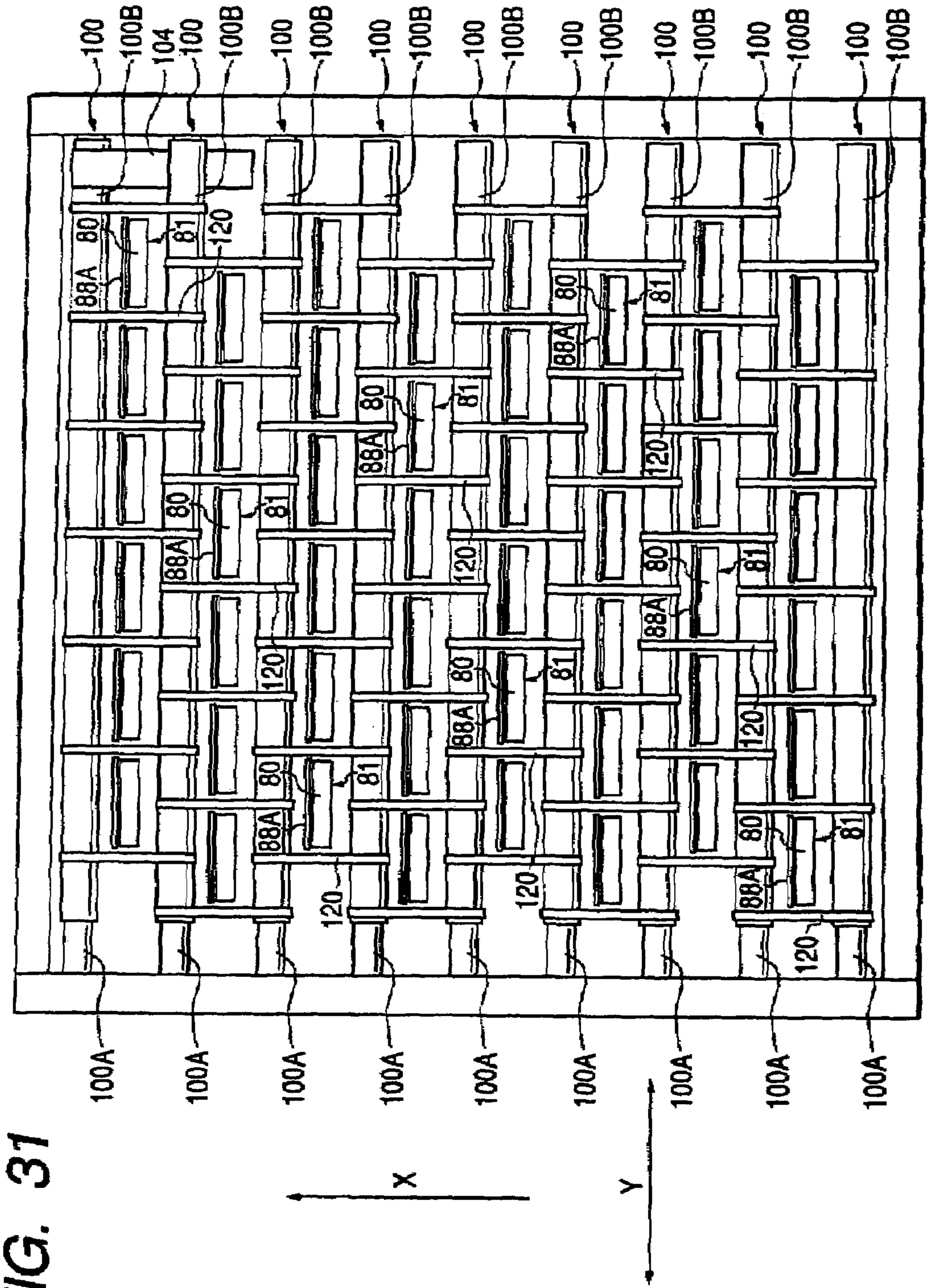


FIG. 31

FIG. 32

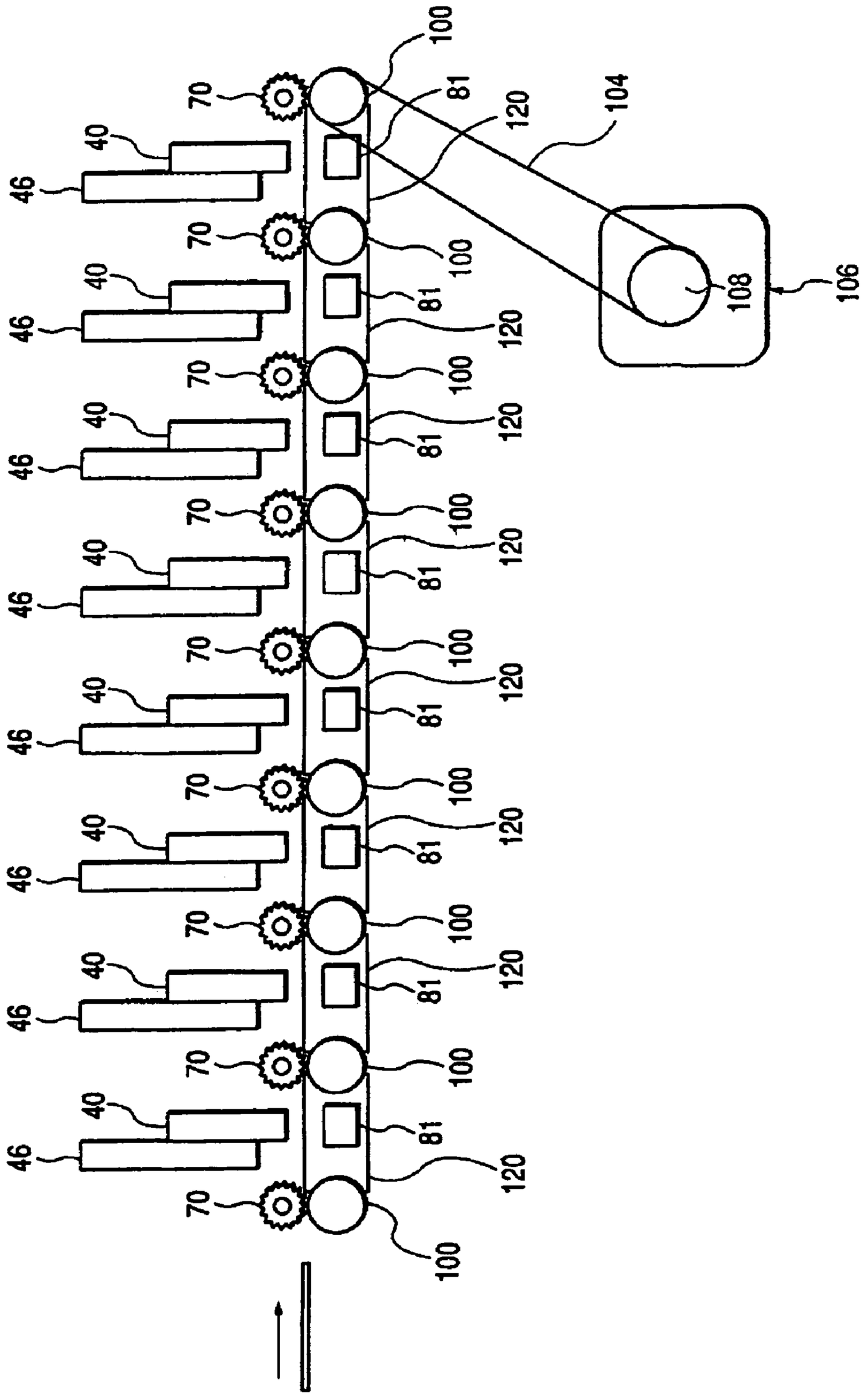


FIG. 33

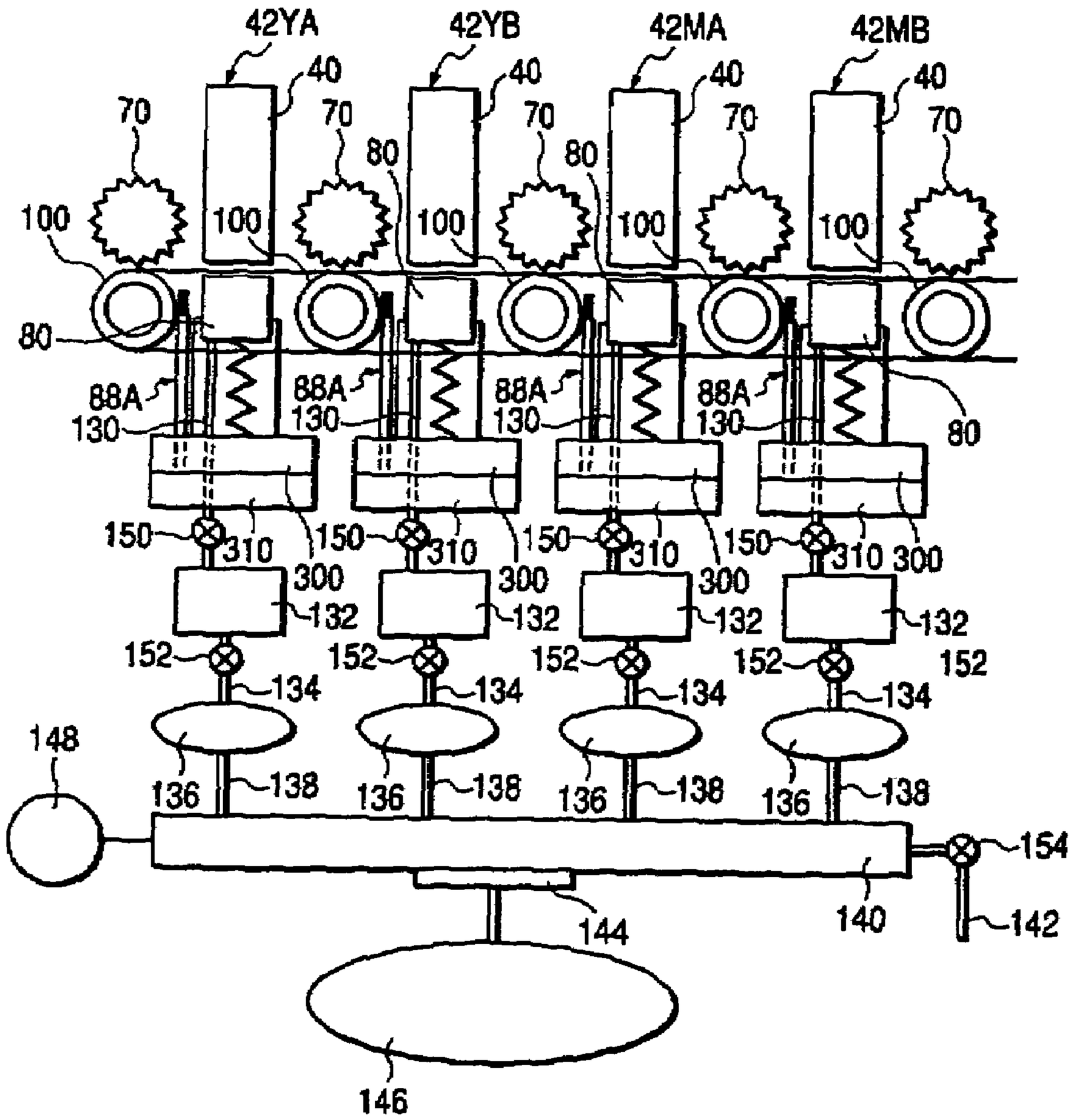

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FIG. 34

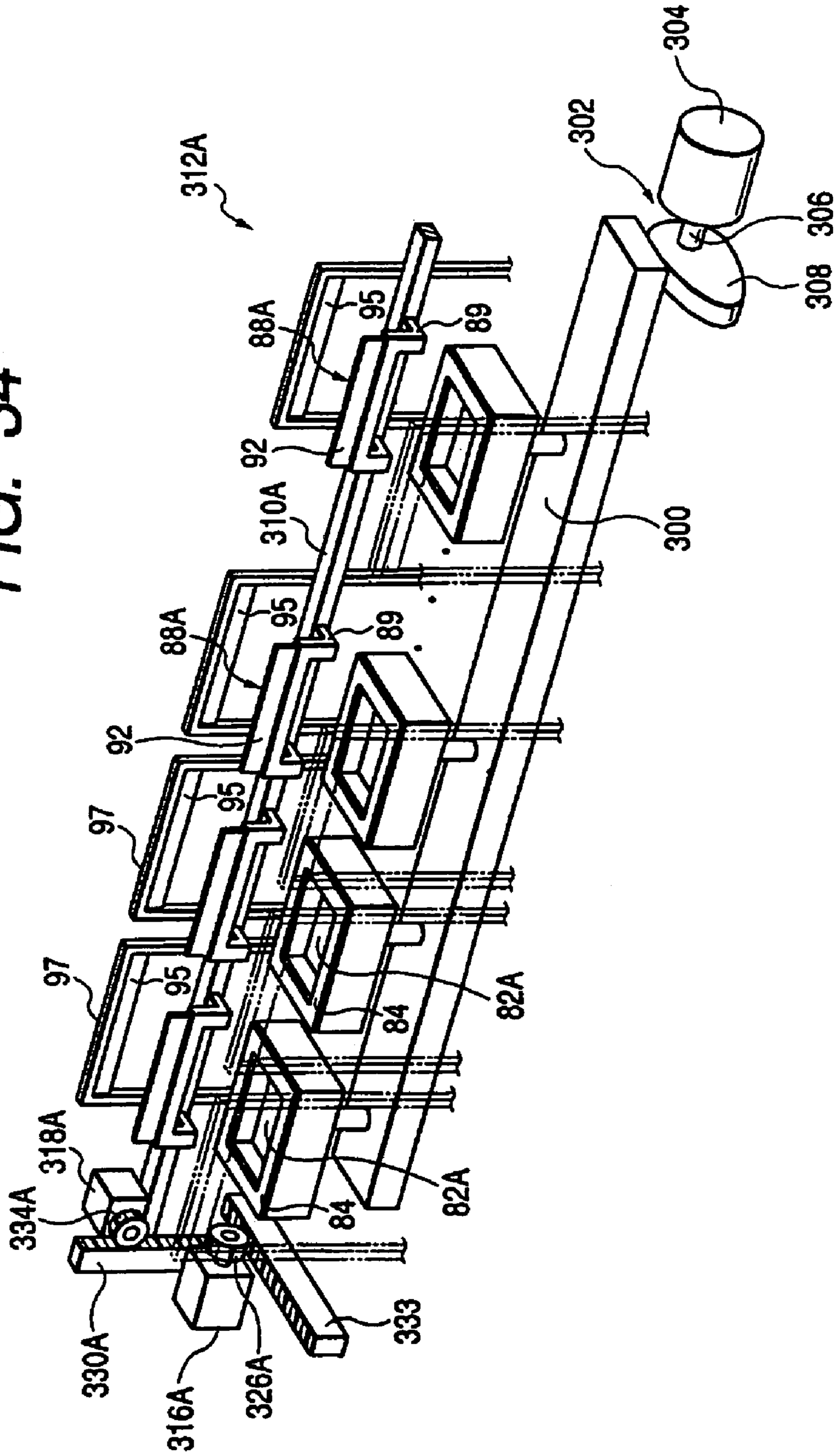
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FIG. 35A

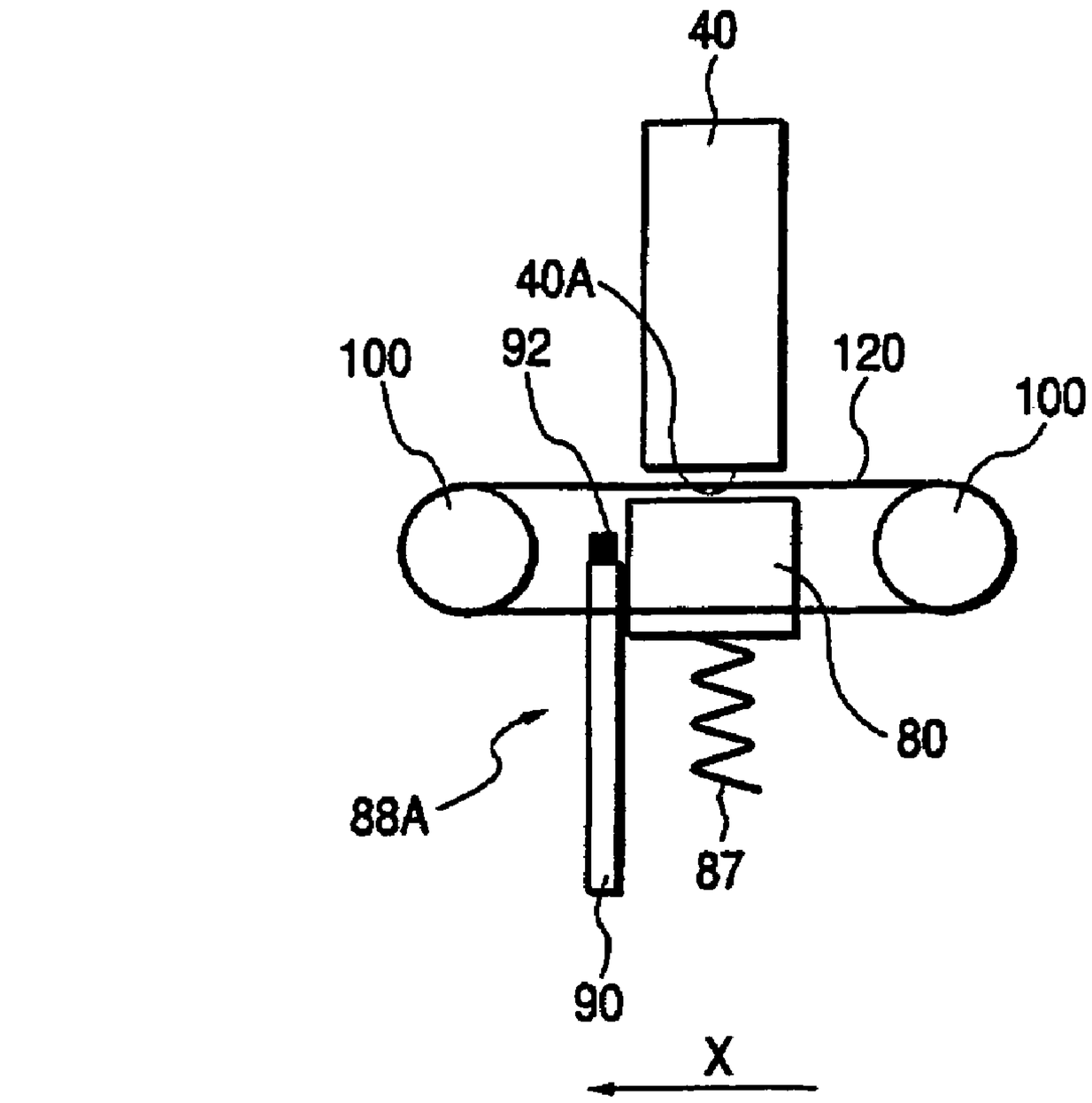


FIG. 35B

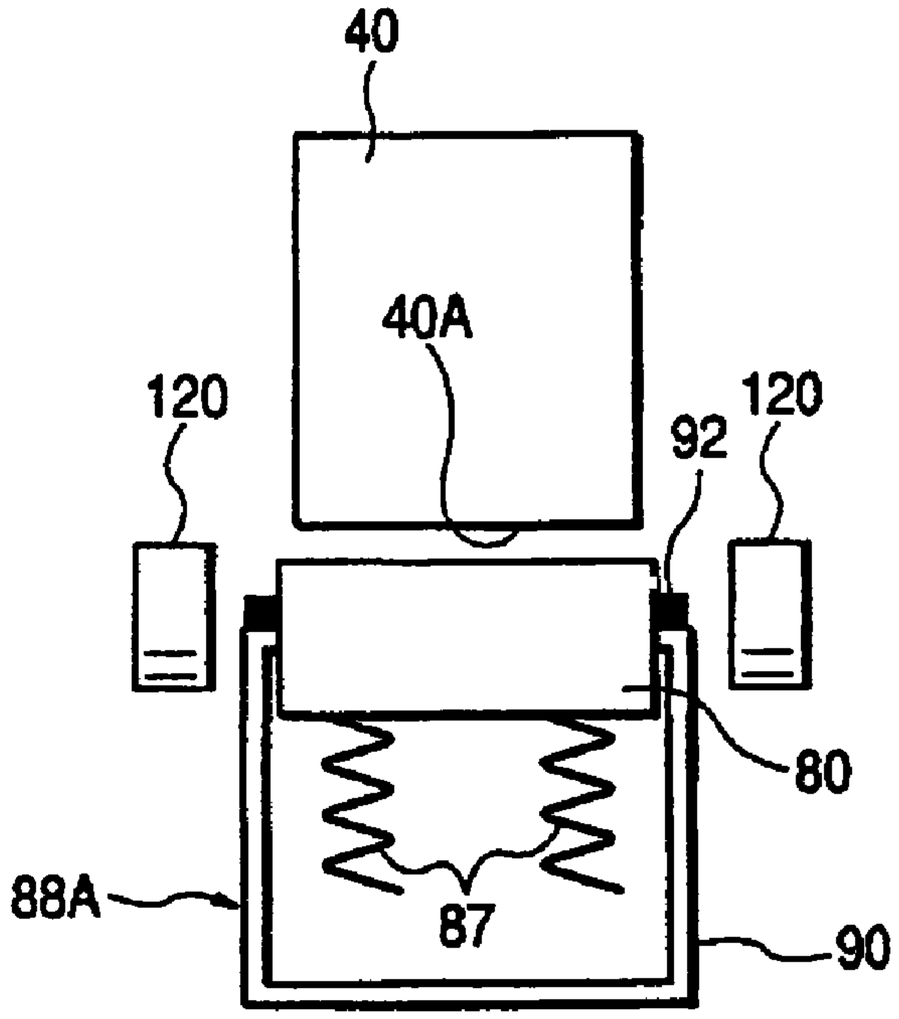


FIG. 36A

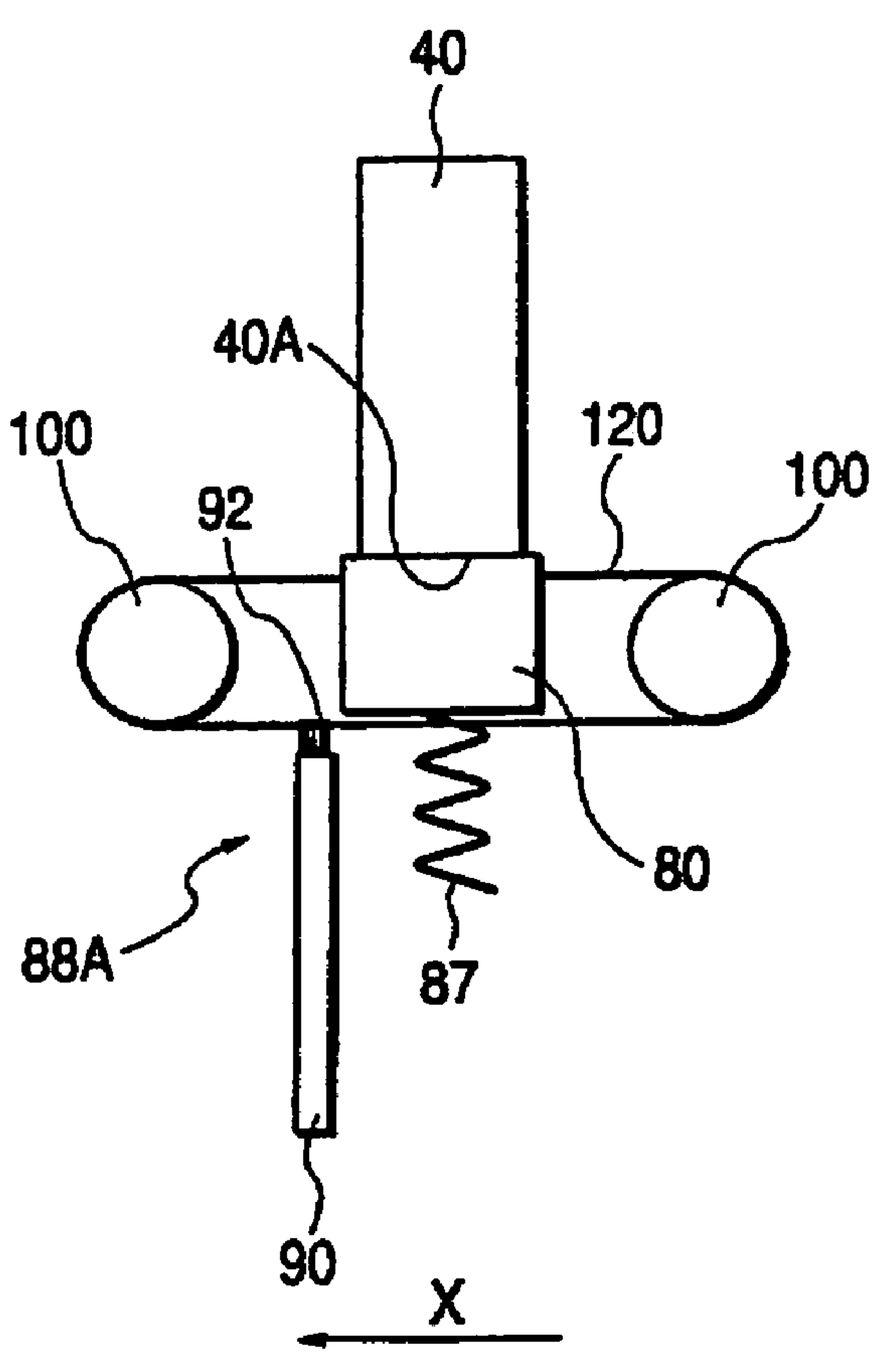


FIG. 36B

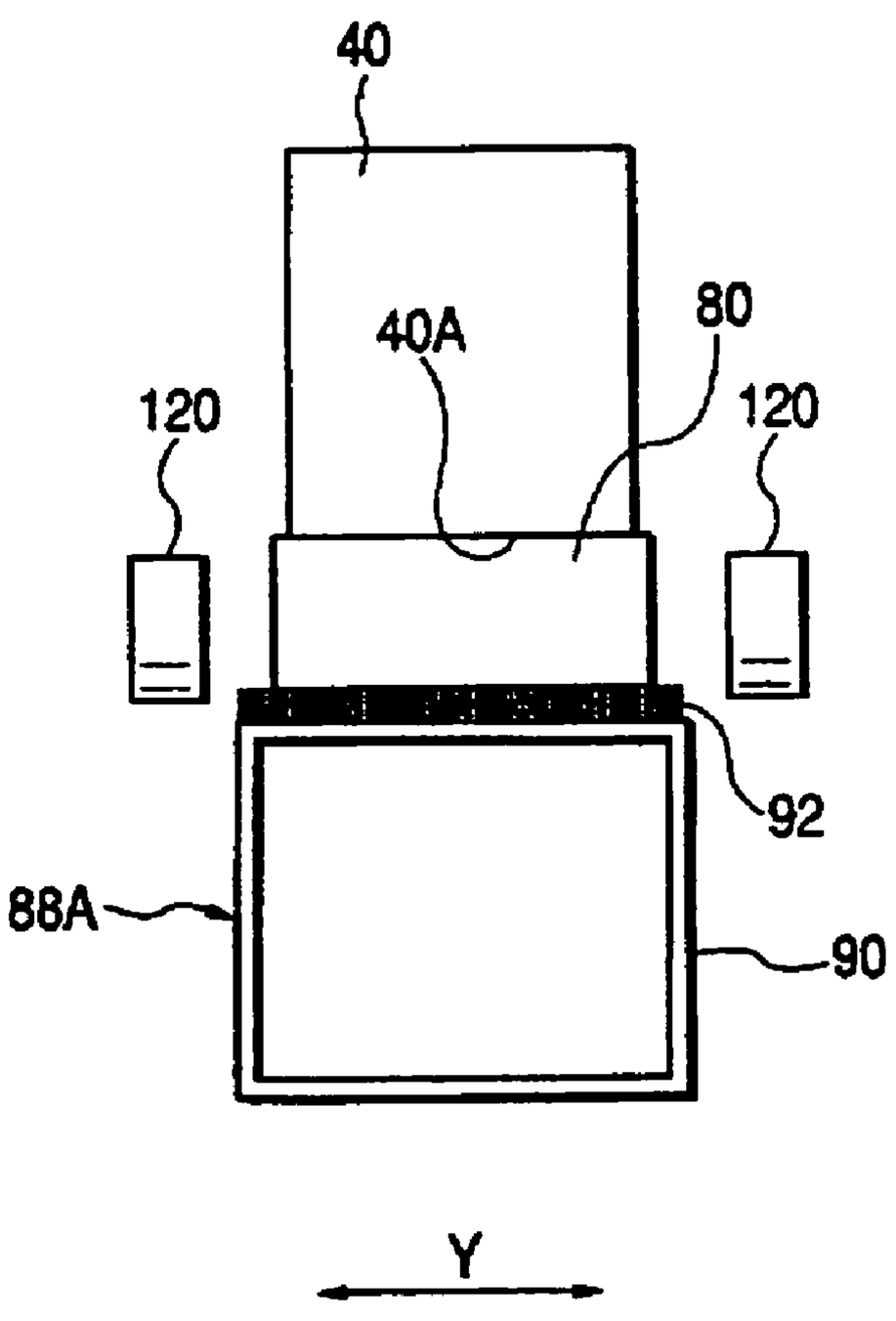
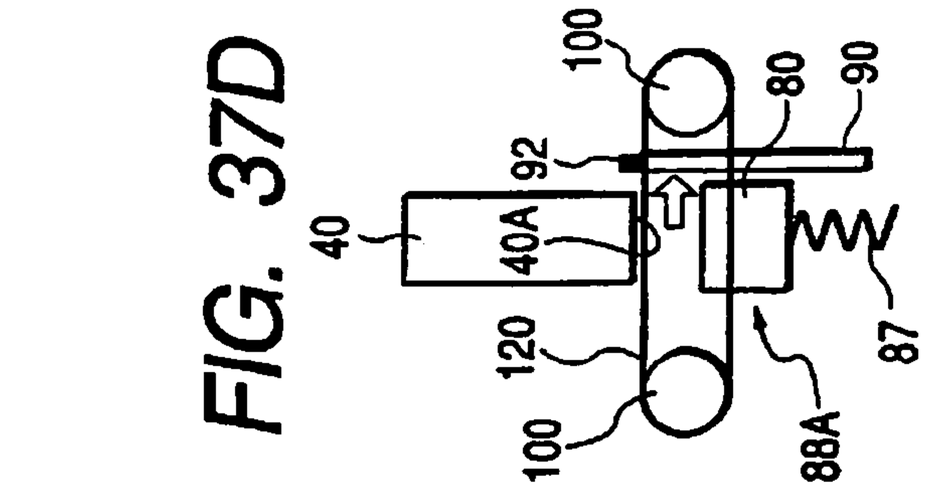


FIG. 37D



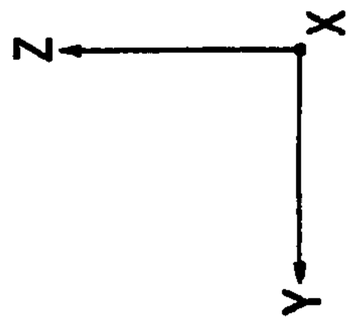


FIG. 37C

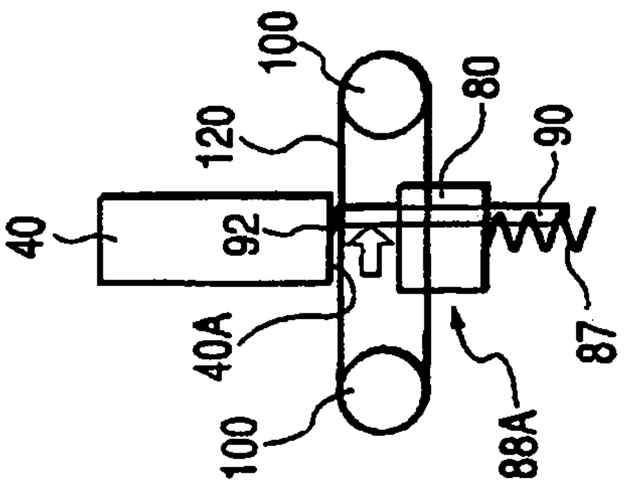


FIG. 37G

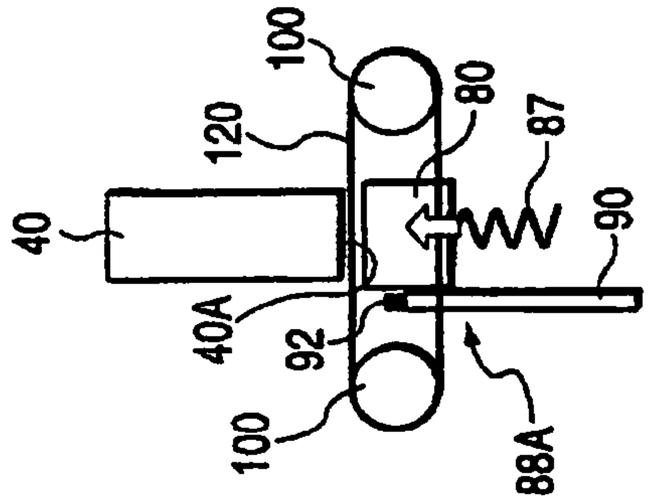


FIG. 37B

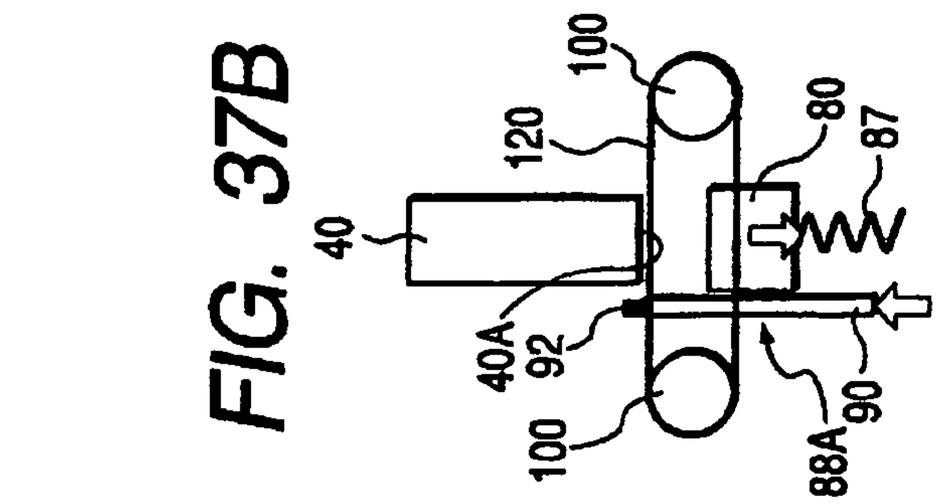


FIG. 37F

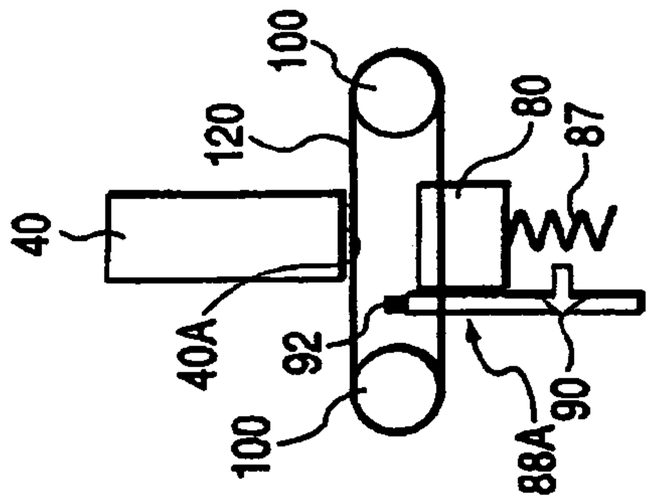


FIG. 37A

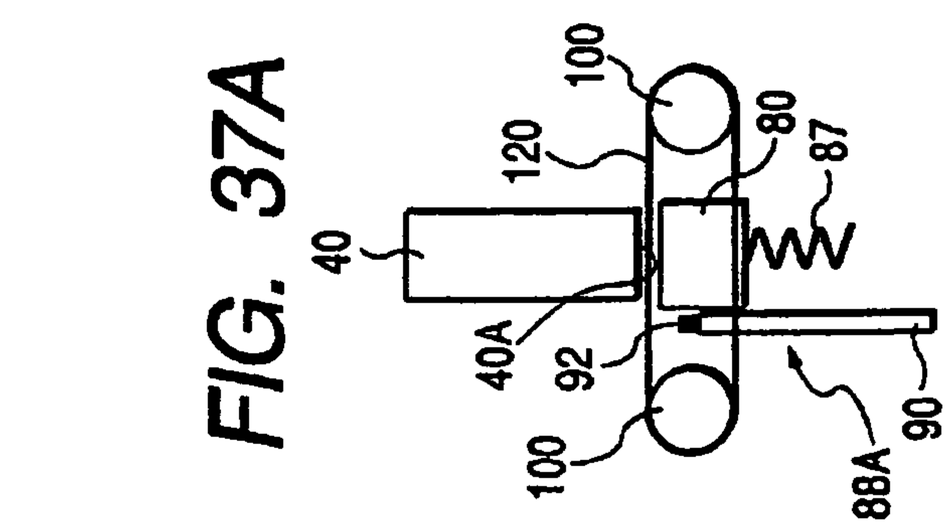
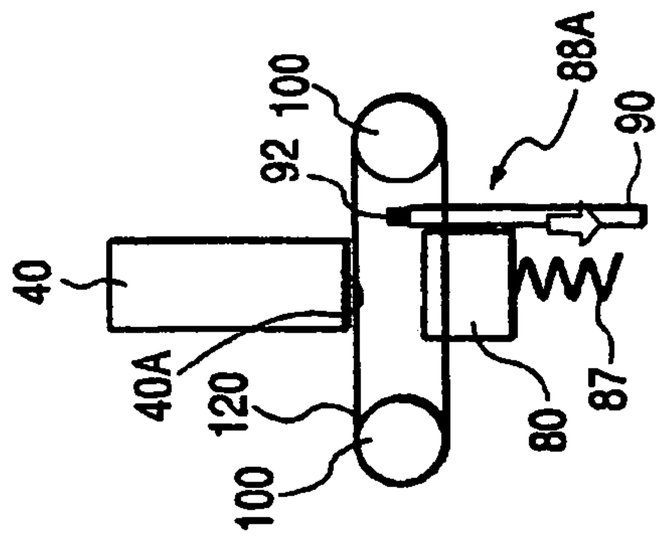


FIG. 37E



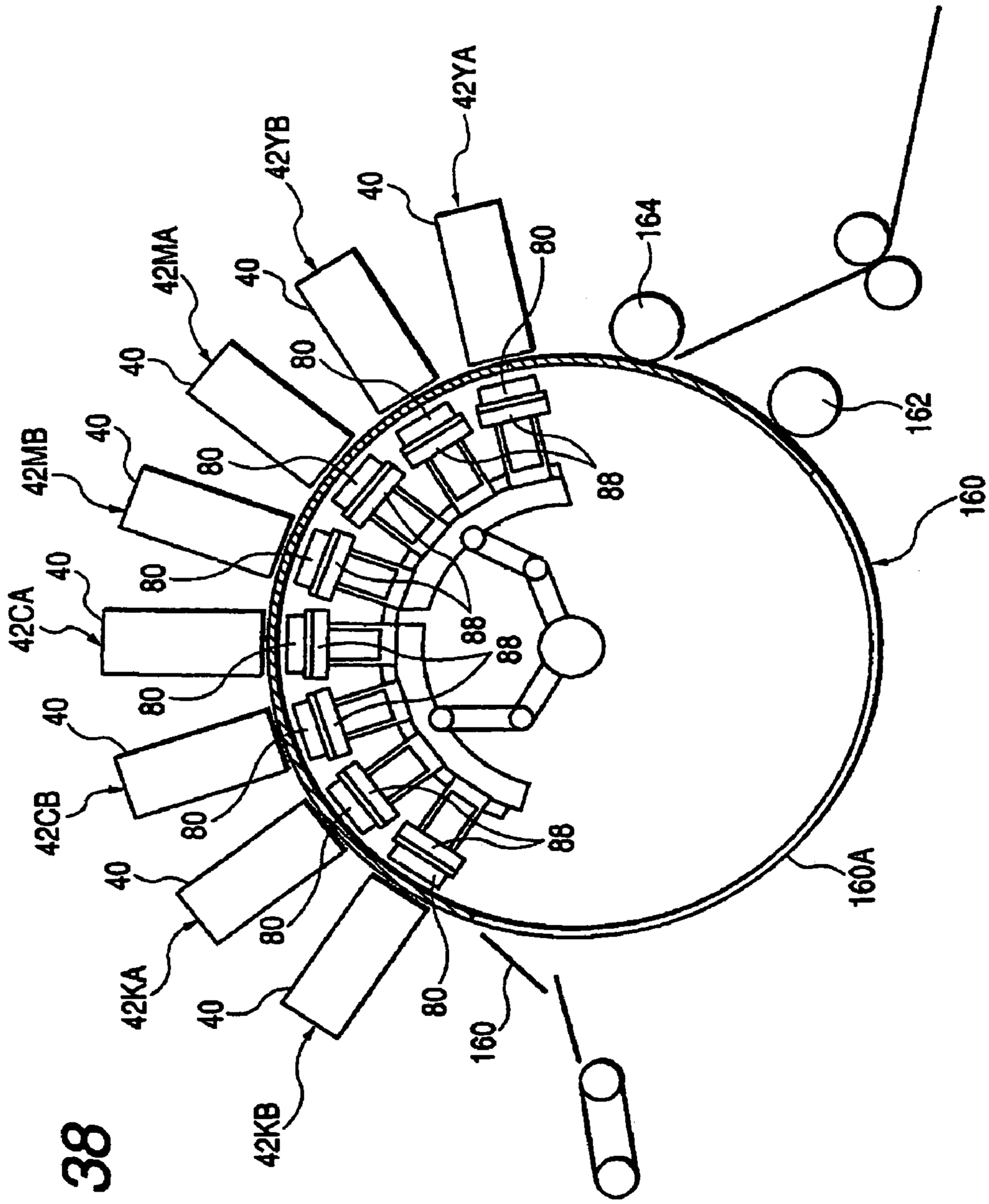

42YB
42YA
40
80
164
42MA
42MB
42CA
42CB
42KA
42KB
88
160
160A
162

FIG. 38

RECORDING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a recording apparatus used as an output device of an ink-jet recording apparatus exerting recordation by ejecting an ink from a recording unit to a recording medium, or an apparatus having such a function, e.g., a facsimile, a duplicator, a printer multifunction machine and a workstation.

2. Description of the Related Art

In recent years, color documents have been widely spread in office use, and various kinds of output apparatuses have been proposed therefor. In particular, an ink-jet system, which can be miniaturized with low cost, is used in various kinds of output apparatuses.

A recording head used in the ink-jet system is constituted with an energy generating unit, an energy converting unit for converting energy generated by the energy generating unit to an ink ejecting force, an ink ejecting outlet for ejecting an ink droplet with the ink ejecting force, and an ink feeding path connected to the ink ejecting outlet for feeding an ink Examples of the energy generating unit include devices using an electromechanical converting element, such as a piezoelectric element, and devices, in which an ink is heated with an electrothermal conversion element having a resistive heater element to form a bubble, and the ink droplet is ejected with the formation of the bubble.

In the recording head utilizing an electrothermal conversion element, not only ink ejecting outlets can be arranged at a high density owing to the small size of the electrothermal conversion element, but also a production technique of a semiconductor integrated circuit can be transferred for the production technique therefor. Accordingly, a recording head having a large number of ink ejecting outlets with high accuracy can be miniaturized and can be produced at low cost.

However, what has been commonly used is a printing system referred to as a serial scanning system, in which a recording head is reciprocally moved with recording paper being conveyed to print by one line. While the system is of a small size and low cost, it has such a problem in that the printing speed is low due to necessity of plural frequencies of scanning of the recording head for forming an image over the paper. It is necessary to lower the scanning frequency in order to improve the printing speed, and extension of a recording head is essential therefor. At the outrance of the extension of a recording head, such a non-scanning printing system is proposed in that a recording head having the same width as recording paper is used. The printing system uses an ink-jet recording apparatus having a recording head having a width equivalent to recording paper, within which a large number of ejecting outlets are arranged over the length, which is substantially the same as the recording paper, and recordation is effected by moving the recoding paper with respect to the fixed recording head.

As described in the foregoing, in order to improve the printing speed to apply to office use, such an ink-jet recording apparatus is proposed that effects printing with a non-scanning recording head corresponding to the paper width on recording paper being continuously conveyed.

In order to maintain good ink ejection performance of an ink-jet recording apparatus, such operations are necessarily carried out with a maintenance device as ejection of an ink droplet in a non-printing state (dummy jet), cleaning of a nozzle surface (wiping), and prevention of an ink from being dried (capping).

For example, in the case where the non-printing state is continued for a prolonged period of time, the ink is dried to clog the nozzle, and dusts are attached to the nozzle surface. As a result, an ink droplet cannot be ejected (dot dropout), or the ejection direction of an ink droplet is changed to lower the printing quality or to disable printing.

Accordingly, in the case where printing is paused for a prescribed period, the recording head is moved from the printing position to a maintenance position within the ink-jet recording apparatus, and dusts attached to the nozzle surface of the recording head are wiped to refresh the nozzle surface.

In order to prevent the ejection performance of an ink droplet from being changed due to change in viscosity of the ink and formation of a bubble, an ink droplet is ejected from the recording head to a receiving member in a non-printing state.

In order to prevent the nozzle surface (nozzle) of the recording head from being dried, furthermore, a cap member is provided. The cap member presses a rubber part onto the nozzle surface to seal the nozzle surface (nozzle) from the exterior.

The ink-jet recording apparatus thus configured as described in the foregoing terminates printing operation after completing printing of a prescribed number of sheets and then effects maintenance operation. Therefore, the productivity is lowered in continuous printing.

In order to solve the problem, proposals have been made, in which a receiving member for receiving dummy jet is disposed at a position opposite to a nozzle surface of a recording head (as described, for example, in JP-A-11-348313 and JP-A-12-15835). In the ink-jet recording apparatus described in JP-A-11-348313 and JP-A-12-15835, a belt for conveying recording paper passes on the downside of the receiving member, whereby the receiving member is disposed at the position opposite to the recording head (nozzle surface). According to the configuration, dummy jet can be ejected onto the receiving member within a period between passage of preceding recording paper and arrival of subsequent recording paper, whereby the productivity is improved.

It has been also proposed that a hole for dummy jet is provided in a belt for conveying to enable ejection of dummy jet during continuous printing, whereby the productivity is improved (as described in JP-A-13-113690).

However, in the techniques described in JP-A-11-348313 and JP-A-12-15835, the recording head is moved from the printing position to the maintenance position upon carrying out the maintenance operation other than dummy jet. In the case where the apparatus is configured to move the recording head between the maintenance position and the printing position, such a problem occurs in that misalignment of the recording head occurs at the, printing position due to the movement to fluctuate the printing quality. Furthermore, another problem occurs in that the constitution of the apparatus is complicated due to the movement of the recording head within the apparatus.

In the case where recording paper is conveyed with a belt having a hole as described in JP-A-13-113690, on the other hand, printed matters can be output without problem in operation for a short period, but there are cases where stress is concentrated to the edge of the hole on the belt in operation for a prolonged period to impair stable running of the belt, whereby printing quality is deteriorated.

SUMMARY OF THE INVENTION

The recording apparatus of the invention contains a recording head for ejecting a liquid droplet to a recording medium, a maintenance device disposed at a position opposite to a liquid droplet ejecting surface of the recording head, and a conveying unit for conveying the recording medium between the recording head and the maintenance device, the maintenance device containing a liquid housing unit for housing the liquid droplet thus ejected from the recording head, and a cleaning unit for cleaning the liquid droplet ejecting surface of the recording head.

BRIEF DESCRIPTION OF DRAWINGS

Preferred embodiments of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a schematic constitutional view showing a recording apparatus according to an embodiment of the invention;

FIG. **2** is an explanatory view showing a printing area of a recording apparatus according to an embodiment of the invention;

FIG. **3** is an explanatory view showing an example of a unit recording head according to an embodiment of the invention;

FIG. **4** is an explanatory view showing an example of a recording head according to an embodiment of the invention;

FIG. **5** is an explanatory view showing another example of a unit recording head according to an embodiment of the invention;

FIG. **6** is an explanatory view showing another example of a recording head according to an embodiment of the invention;

FIG. **7** is an explanatory view showing still another example of a recording head according to an embodiment of the invention;

FIG. **8** is an explanatory view showing still another example of a unit recording head according to an embodiment of the invention;

FIG. **9** is a perspective explanatory view showing a maintenance device according to an embodiment of the invention;

FIGS. **10**A to **10**C are operational explanatory views showing a maintenance device according to an embodiment of the invention;

FIG. **11** is an explanatory view showing an example of a maintenance device according to an embodiment of the invention;

FIG. **12** is an explanatory view showing another example of a maintenance device according to an embodiment of the invention;

FIG. **13** is a schematic constitutional view showing a recording apparatus according to Example 1 of the invention;

FIG. **14** is a schematic plane view showing a recording head part according to Example 1 of the invention;

FIG. **15** is a plane view showing a unit recording head according to Example 1 of the invention;

FIG. **16** is a constitutional explanatory view showing a recording head array according to Example 1 of the invention;.

FIG. **17** is a vertical cross sectional view showing a recording part according to Example 1 of the invention;

FIG. **18** is a side view of an important part of a recording part of Example 1 of the invention;

FIG. **19**A is a cross sectional view showing a star wheel, FIG. **19**B is a side view thereof, and FIG. **19**C is a side view of another example thereof;

FIG. **20** is a schematic plane view showing a maintenance part according to Example 1 of the invention;

FIG. **21** is a perspective explanatory view showing an important part of a maintenance part according to Example 1 of the invention;

FIG. **22** is an explanatory view showing an elevating mechanism and a moving mechanism of a maintenance part according to Example 1 of the invention;

FIGS. **23**A to **23**G are operational explanatory views showing wiping operation in a recording apparatus according to Example 1 of the invention;

FIG. **24** is an explanatory view showing a driving mechanism of a recording apparatus according to Example 1 of the invention;

FIG. **25** is a plane explanatory view showing an important part of a paper conveying mechanism according to Example 1 of the invention;

FIGS. **26**A and **26**B are operational explanatory views showing capping operation in a recording apparatus according to Example 1 of the invention;

FIGS. **27**A and **27**B are operational explanatory views of a moving mechanism of a recording apparatus according to Examples 1 and 2 of the invention.

FIG. **28**A is a flow chart showing operation of a maintenance part according to Example 1 of the invention, and FIG. **28**B is a flow chart showing operation of a maintenance part according to Example 2 of the invention.

FIG. **29** is a disassembled view showing a constitution of a removing member according to Example 2 of the invention.

FIG. **30** is an explanatory view showing a state where a wiping member is cleaned according to Example 2 of the invention.

FIG. **31** is a schematic plane view showing a maintenance part according to Example 2 of the invention;

FIG. **32** is an explanatory view showing a driving mechanism of a recording apparatus according to Example 2 of the invention;

FIG. **33** is an explanatory view showing a waste ink recovering mechanism of a recording apparatus according to Example 2 of the invention;

FIG. **34** is an explanatory view showing an elevation mechanism and sliding mechanism of the maintenance mechanism of example 3.

FIGS. **35**A and **35**B are explanatory views showing a home position of a cap member according to Example 2 of the invention;

FIGS. **36**A and **36**B are explanatory views showing a cap position of a cap member according to Example 2 of the invention;

FIGS. **37**A to **37**G are operational explanatory views showing wiping operation in a recording apparatus according to Example 2 of the invention; and

FIG. **38** is a schematic explanatory view showing a recording part of a recording apparatus according to Example 3 of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A recording apparatus according to an embodiment of the invention win be described.

As shown in FIG. **1**, a recording apparatus **200** has a recording head **44** and a maintenance device **81** disposed as being opposite to the recording head **44**.

The recording head **44** is not limited in species of an ink and the ejecting system for an ink droplet as far as it can eject an ink droplet from a nozzle surface **40**A of the recording head **44**. While the ejecting system of ink droplets of a unit recording head **40**, which will be described later, is referred to be an ink-jet system, it is not limited thereto as far as it is a noncontact system capable of transferring a colorant directly to paper. Representative examples of the ejection system include an ink-jet system, but any known system may be applied thereto. The ink-jet system is not limited, and examples thereof include a thermal ink-jet system, a piezoelectric ink-jet system, a continuous flow ink-jet system and an electrostatic suction ink-jet system.

The ink used herein is not limited, and examples thereof include an aqueous ink an oily ink, a so called solid ink, which is in a solid state at ordinary temperatures, and a solvent ink. A colorant contained in the ink may be either a pigment or a dye.

The printing area of the recording head **44** is set as corresponding to a maximum paper width PW of paper P to be printed, as shown in FIG. **2**. The printing area referred herein basically means the maximum width of the recording area, which is the full width of the paper except for margins on both sides, on which no printing is effected, but is generally larger than the maximum paper width PW, on which printing is effected. This is because there is such a possibility that paper is conveyed as being skewed at a certain angle with respect to the conveying direction, and there is an increasing demand of rimless printing.

The recording head **44** may be constituted with a long monolithic recording head chip or with plural short recording head chips (hereinafter refereed to as unit recording heads).

In the case where the recording head is constituted with plural unit recording heads, the following embodiment can be exemplified.

For example, in the case where a unit recording head **110** has nozzles **58** formed to both ends of the nozzle arranging direction as shown in FIG. **3**, the unit recording heads **110** are continuously arranged in the nozzle arranging direction to constitute compactly a recording head **44** shown in FIG. **4**. In the case where a unit recording head **40** has nozzles **58** thereon except for both ends as shown in FIG. **5**, a recording head **44** capable of printing over the paper width without gap can be constituted in such a manner that plural recording head arrays **42**A and **42**B, each of which has plural unit recording heads **40** arranged on a common substrate **46**A or **46**B at a constant interval in the nozzle arranging direction, are arranged in the conveying direction as shown in FIG. **6**. In this case, further miniaturization can be attained by constituting the recording head arrays **42**A and **42**B on both surfaces of a single common substrate **46** as shown in FIG. **7**.

While the arrangement of the nozzles in the unit recording heads **40** and **110** is of a straight form but is not limited thereto, and for example, nozzles may be arranged in a staggered form as shown in FIG. **8**.

The recording apparatus **200** has four recording heads **44** in the conveying direction, from which ink droplets of yellow (Y), magenta (M), cyan (C) and black (K) are ejected therefrom, respectively, so as to attain full color printing.

A maintenance device **81** disposed opposite to the recording head **44** has a cap unit (ink housing unit) **80** capable of housing an ink droplet and a cleaning unit **88** capable of cleaning a nozzle surface **40**A of the recording head **44**, as shown in FIG. **9**.

The cap unit **80** has, as a minimal function, a function of housing a liquid droplet ejected from the recording head **44** upon dummy jet, which will be described later. In order therefor, as shown in FIG. **9**, for example, it has a receiving member **82** having a concave part **82**A formed corresponding to the nozzle surface **40**A of the recording head **44**, and an ink absorbent **86** for retaining an ink disposed at a bottom of the concave part **82**A of the receiving member **82**.

The cap unit **80** may also has other functions than the minimal function. For example, the cap unit **80** may be constituted as being capable of approaching to and leaving from the nozzle surface **40**A of the recording head **44** (hereinafter referred to as elevating) with an elevating unit **302**, and the cap unit **80** is pressed onto the nozzle surface **40**A to seal the nozzle surface **40**A (i.e., capping), as shown in FIGS. **10**A to **10**C. In this case, it is necessary to provide a rubber member **84** on an upper part (the nozzle surface side) of the receiving member **82** in order to seal the nozzle surface **40**A of the recording head **44** upon pressing, as shown in FIG. **9**. The cap unit **80** (rubber member **84**) maybe constituted to cover the entire nozzle surface in order to prevent a recording liquid in the nozzles from being dried and to prevent attachment of dirt and dusts to the nozzle surface **40**A.

The receiving member **82** may be constituted with a plastic material, and examples of the plastic material include POM, PET, PBT, PPS, nylon 66, acrylic resins and Bakelite, and PBT is preferred from the standpoint of mold ability, impact resistance and the like.

Examples of the rubber material constituting an elastic member used as the rubber member **84** include various kinds of natural rubber and elastomers, such as caoutchouc, isoprene rubber, butadiene rubber, olefin rubber, ether rubber, polysulfide rubber, urethane rubber, fluorinated rubber and silicone rubber as well as blended rubber of these rubber materials, and blended rubber of the rubber material and various kinds of plastics. These materials may be combined by adhesion or the like means.

Among these materials, hydrogenated nitrile butadiene rubber, ethylene propylene rubber (EPDM), polydimethylsilicone rubber, methylvinylsilicone rubber, methylphenylsilicone rubber and fluorosilicone rubber are preferred from the standpoint of weather resistance, chemical resistance, wear resistance and workability.

Examples of a material of the ink absorbent **86** include a polyester felt fibrous material and an acrylonitrile felt fibrous material, and a mixture of a polyester felt fibrous material and an acrylonitrile felt fibrous material can also be preferably used The ink holding capability of the ink absorbent **86** can be finely adjusted by appropriately changing the fiber diameter, the fiber length and the arranging direction of the fibrous material used.

Examples thereof also include a polyamide fibrous material, a polypropylene fibrous material, a polyvinyl alcohol fibrous material, a polyvinylidene chloride fibrous material and a polyurethane fibrous material.

A polyester fibrous material is preferably used from the standpoint of absorbance of a recording liquid such as an ink, and a mixed system of these materials may also be preferably used.

The cleaning unit **88** is to remove dirt, dusts and an ink on the nozzle surface **40**A on the recording head **44** to maintain the constant ejecting capability of an ink droplet.

The cleaning unit **88** is constituted with a wiper **92**, a retaining member **90** for retaking the wiper **92** as shown in FIG. **9**, and a moving unit **312** (as shown in FIGS. **10**A to **10**C) for moving the cleaning unit **88** in the elevational direction and the widthwise direction.

The wiping member **88** is constituted as shown in FIGS. **17** and **32**, so that all the wiping members **88** corresponding to the unit recording heads **40** constituting the recording head array **42** are unitized by attaching them to the common substrate **310** and are integrally capable of approaching and leaving the nozzle surface **40**A of the unit recording head **40** and of moving in the width direction by the moving mechanism **312**.

Specifically, the moving mechanism **312** is basically constituted with a slider **314** supporting the common substrate **310** movably in the width direction, a driving motor **316** for moving the common substrate **310** on the slider **314** in the width direction, and a driving motor **318** for elevating the slider **314**. The slider **314** has guides **320**, which are provided on both ends in the conveying direction and extend in the width direction, and thereby the wiping members **88** are integrally movable in the width direction of paper through the common substrate **310** as guided by the guide **320**.

A rack **322** extends from one end of the common substrate **310** and is engaged with a driver gear **326** directly connected to a driving motor **316** fixed to the casing **102**. Accordingly, the wiping members **88** are integrally movable in the width direction of paper through the common substrate **310** on the slider **314** by the driving by the driving motor **316**.

A protrusion **332** having a rack **330** formed thereon and extending in the vertical direction is provided on a lower surface of the slider **314**, which is engaged with a driving gear **334** of the driving motor **318**. Accordingly, the slider **314** can be elevated by driving the driving motor **318**. Consequently, the wiping members **88** are integrally elevated through the common substrate **310** supported by the slider **314**.

According to the constitution, the wiper **92** is moved by the moving mechanism **312** along the nozzle surface **40**A of the unit recording head **40** as being in slidably contact with the nozzle surface **40**A as shown in FIGS. **10**A to **10**C, whereby the entire nozzle surface **40**A of the unit recording head **40** is cleaned.

At this time, the cap member **80** is disposed at a position opposite to the recording head **44**, and therefore, the wiping member **88** is moved between the recording head **44** (i.e. the nozzle surface **40**A) and the cap member **80**.

For example, the constitution shown in FIG. **9** can be employed, in which upon moving the wiping member **88** between the recording head **44** (i.e., the nozzle surface **40**A) and the cap member **80**, the retaining member **90** of the wiping member **88** is moved over the cap member **80**. The moving direction (moving in slidably contact therewith) of the wiper **92** may be, for example, the paper conveying direction (the direction shown by the arrow X) or a widthwise direction (the direction shown by the arrow Y) perpendicular to the paper conveying direction. The movement may be unidirectional or reciprocal.

The wiper **92** is moved with the moving unit **312** along the nozzle surface **40**A of the recording head **44** as being in slidably contact with the nozzle surface **40**A as shown in FIG. **10**C, so as to effect cleaning of the entire nozzle surface. At this time, the cap unit **80** is disposed at a position opposite to the recording head **44**, and therefore, the cleaning unit **88** is moved between the recording head **44** (i.e., the nozzle surface **40**A) and the cap unit **80**. For example, the constitution shown in FIG. **9** can be employed, in which the retaining member **90** of the cleaning unit **88** is formed into a gantry shape, and the wiper **92** is moved over the cap unit **80** as being pressed onto the nozzle surface **40**A of the recording head **44**.

The moving direction (moving in slidably contact therewith) of the wiper **92** may be, for example, the paper conveying direction or a widthwise direction perpendicular to the paper conveying direction. The movement thereof may be unidirectional or reciprocal.

The retaining member **90** for retaining the wiper **92** may be constituted with a metallic material having a certain strength, such as aluminum and stainless steel.

The wiper **92** preferably has, in order to obtain a prescribed stiffness, a rubber hardness of from 30 to 80, a ratio of a length in longitudinal (conveying) direction L**1** and a width in crosswise (widthwise) direction W**1** of from 5/1 to 50/1, and a width W**1** of from 0.5 to 4 mm. In the case where the rubber-hardness is less than 30, the ratio of the length L**1** and the width W**1** is larger than 50/1, or the width W**1** is less than 0.5 mm, the wiper **92** is too low in stiffness and cannot be sufficiency in contact with the nozzle surface **40**A, so as to toughen the cleaning operation. In the case where the rubber hardness is larger than 80, the ratio of the length L**1** and the width W**1** is less than 5/1, or the width W**1** is larger than 4 mm, the wiper **92** is too high in stiffness and cannot be sufficiently in contact with the nozzle surface **40**A, so as to toughen the cleaning operation.

Examples of the rubber material constituting an elastic member used as the wiper **92** include various kinds of natural rubber and elastomers, such as caoutchouc, isoprene rubber, butadiene rubber, olefin rubber, ether rubber, polysulfide rubber, urethane rubber, fluorinated rubber and silicone rubber, as well as blended rubber of these rubber materials, and blended rubber of the rubber material and various kinds of plastics. These materials may be combined by adhesion or the like means.

Among these materials, hydrogenated nitrile butadiene rubber, ethylene propylene rubber (EPDM), polydimethylsilicone rubber, methylvinylsilicone rubber, methylphenylsilicone rubber and fluorosilicone rubber are preferred from the standpoint of weather resistance, chemical resistance, wear resistance and workability.

A thermoplastic elastomer excellent in fatigue resistance, molding resistance and rubber characteristics is also preferred.

The surface of the wiper **92** may be covered with a protective layer. The protective layer is preferably formed with a fluorine resin, which is excellent in liquid repelling property and low friction characteristics.

Various kinds of plastic materials may also be applied. Specific examples of the plastic material include molded articles of a polyester resin, such as polyethylene terephthalate and polybutylene terephthalate, a polyvinyl chloride resin, a polyvinylidene chloride resign, an epoxy resin, a polycarbonate resin, a polyethylene resin, a polypropylene resin and a polystyrene resin.

Such a material may also be used that is obtained by accumulating and adhering film articles of these materials, followed by accurately cutting. An adhesive used herein is preferably an acrylic polymer and a rubber polymer.

While the case where the ink absorbent **86** is used as a unit for recovering an ink (ink droplet) in this embodiment, it is not limited thereto. For, example, in the case of the constitution where the cap unit **80** can be pressed onto the nozzle surface **40**A of the recording head **44**, a negative pressure suction device **252** capable of applying a negative pressure

is connected to the cap unit **80** (the concave part **82**A) through a tube **250**, as shown in FIG. **11**, whereby the ink and dusts on the nozzle surface **40**A of the recording head **44** and the ink having an increased viscosity in the nozzle are recovered upon pressing thereon, and the ink accumulated in the cap unit **80** (the receiving member **82**) is recovered upon releasing therefrom.

Specific examples of the constitution include that shown in FIG. **12** containing a tank **256** connected to the cap unit **80** (the concave part **82**A) through a tube **254**, and a negative pressure generating device **260** connected to the tank **256** through a tube **258** as shown in FIG. **12**. An electromagnetic valve **262** is disposed between the cap unit **80** and the tank **256**.

It is possible in this constitution that the negative pressure generating device **260** is driven to generate a negative pressure in the state where the electromagnetic valve **262** is closed, and at the time when the pressure in the tank **256** reaches about from −30 to −100 kPa with respect to the atmospheric pressure, the electromagnetic valve **262** is released, whereby the ink or the like in the concave part **82**A of the cap unit **80** is sucked at once.

The function of the recording apparatus according to this embodiment of the invention thus constituted will be described.

The maintenance operation (dummy jet, wiping, capping and vacuuming) of the recording apparatus will be briefly described.

The dummy jet may be carried out at any time when no paper is present between the recording head **44** and the maintenance device **81**. In other words, it may be carried out not only in the non-printing state, but also within a period between passage of preceding recording paper and arrival of subsequent recording paper during continuous printing of plural sheets of paper.

At the aforementioned timings, ink droplets are ejected from the respective nozzles without moving the recording head **44** from the printing position, whereby the ink droplets are housed in the cap unit **80**. That is, the ink having an increased viscosity and the bubbles are ejected from the nozzles to initialize the ejecting performance of an ink droplet of the recording head **44**. En the case where the cap unit **80** has the receiving member **82** having the concave part **82**A, the ink droplets are housed and retained in the concave part **82**A to prevent splash. In the case where the concave part **82**A has an ink absorbent **86** inside, splash can be further certainly prevented, and the ink can be retained (recovered) through absorption.

Upon carrying out the dummy jet, the cap unit **80** and the cleaning unit **88** are not operated.

The wiping is carried out after printing but before conveying, or is carried out before printing. At this time, the cleaning unit **88**, for example, the wiper **92** is in slidably contact with the nozzle surface **40**A of the recording head **44** with the moving unit **312** as shown in FIG. **10**C, whereby the ink and dusts on the nozzle surface **40**A are removed to improve the ejecting performance of an ink droplet.

Since the cap unit **80** is disposed at a position opposite to the nozzle surface **40**A, the cleaning unit **88** carries out the cleaning operation by moving to pass between the cap unit **80** and the nozzle surface **40**A.

As shown in FIGS. **17** and **22**, all the wiping members **88** corresponding the unit recording heads **40** constituting the recording head array, **42** are attached to the common substrate **310** and unitized, and they can integrally approach to and leave from the nozzle surface **40**A of the unit recording head **40** with an elevating mechanism **312**.

In the case of wiping members **88** cleaning the individual unit recording heads **40** in independent states, fluctuation occurs in operation of the wiping members **88** due to the complexity of the apparatus, whereby the cleaning operation becomes unstable, and the setting of the operation becomes difficult. In the case where the wiping members **88** are integrally moved for the recording head array **42** constituted by the plural unit recording heads **40** arranged in parallel, however, the constitution of the apparatus itself can be simplified to obtain stable cleaning operation.

While the wiping members **88** are moved in the width direction of the conveyed paper herein, the invention is not limited thereto, but they may be moved in the conveying direction (specific constitutions thereof will be described in Example 3) because it is sufficient that the wiping members **88** are integrally moved.

The capping operation is to prevent the ink in the nozzles of the recording head **44** from being dried and to prevent dusts from being attached to the nozzle surface **40**A upon suspending the apparatus and in the non-printing state, and can be carried out only in the case where the cap member **80** can be elevated with an elevating mechanism **302**, as shown in FIGS. **10**A and **10**B.

The capping is to prevent the ink in the nozzles of the recording head **44** from being dried and to prevent dusts from being attached to the nozzle surface **40**A upon suspending the apparatus and on non-printing, and can be carried out only in the case where the cap unit **80** can be elevated with an elevating unit **302**. The cap unit **80**, for example, a rubber part **84** is pressed onto the nozzle surface **40**A with the elevating unit **302** to maintain the nozzle surface **40**A being sealed, whereby the nozzle surface **40**A and the ink in the nozzles are prevented from being dried and increased in viscosity.

The vacuuming is to suck the ink in the nozzles of the recording head **44** and the ink retained by the cap unit **80**, and is carried out upon non-printing. Specifically, the cap unit **80** is pressed onto the nozzle surface **40**A with the elevating unit **302**, and the negative pressure suction device **252** is driven (i.e., the negative pressure generating device **260** and the electromagnetic valve **262** are driven) to suck the ink in the nozzles and the ink retained by the cap unit **80**, which are then recovered, for example, in the tank **256**.

According to the series of maintenance operation having been described, the recording apparatus **200** can maintain good ink ejecting performance and can effect printing with high image quality.

Furthermore, there is no necessity of moving the recording head **44** from the printing position upon carrying out the maintenance operation. Therefore, the recording head **44** is prevented from suffering misalignment caused by moving the recording head **44** between the printing position and the maintenance position to fluctuate the printing quality, whereby the printing quality can be maintained constant. Moreover, no moving mechanism is required for the recording head **44**, and thus the mechanism of the apparatus can be simplified.

In the case where the recording head **44** is constituted with plural unit recording heads **40**, the plural maintenance devices **81** may be provided for the respective unit recording heads **40**, or in alternative, the single maintenance device **81** may be provided for the plural unit recording heads **40**.

In the case where the plural maintenance devices **81** are provided for the respective unit recording heads **40**, the plural maintenance devices **81** (including the cap units **80** and the cleaning units **88**) may be moved with a single set of an elevating unit **302** and a moving unit **312**.

EXAMPLE 1

An ink-jet recording apparatus having a recording apparatus according to Example 1 of the invention will be described. The same constitutional elements as in the aforementioned embodiment are attached with the same symbols, and detailed descriptions thereof are omitted herein.

Overall Constitution of Ink-jet Recording Apparatus

The overall constitution of the ink-jet recording apparatus will be briefly described.

As shown in FIG. **13**, the ink-jet recording apparatus **10** is basically constituted with a paper feeding part **12** for dispatching paper, a registration adjustment part **14** for controlling the orientation of the paper, a recording, part **20** having a recording head part **16** for forming an image on the paper by ejecting ink droplets and a maintenance part **18** for carrying out maintenance of the recording head part **16**, and a paper delivery part **22** for delivering the paper having an image formed thereon in the recording part **20**.

The paper feeding part **12** is constituted with a stocker **24** having accumulated sheets of paper stocked therein, and a conveying device **26** for conveying a sheet of paper one by one from the stocker **24** to the registration part **14**.

The registration part **14** has a loop forming part **28** and a guide member **30** for controlling tie orientation of the paper, and upon passing the paper through the registration part **14**, skew of the paper is corrected, and the conveying timing is controlled to be fed to the recording part **20**.

The recording part **20** has a paper conveying path, in which the paper is conveyed between the recording head part **16** and the maintenance part **18**, and an image is formed on the paper, which is continuously (without stoppage) conveyed on the paper conveying path, by ejecting ink droplets from the recording head part **16** Pairs of the recording head part **16** and the maintenance part **18** are unitized, respectively, and the recording head part **16** is construed as being removably from the maintenance part **18** disposed opposite thereto with the paper conveying path intervening therebetween. Therefore, in the case of paper jam, jammed paper can be easily removed. The recording part **20** will be described in detail later, and descriptions thereof are omitted herein.

The paper delivery part **22** houses the paper having an image formed in the recording part **20** in a tray **32** through a paper delivery belt **31**.

Constitution of Recording Head Part

The recording head part **16** will be described in detail with reference to FIGS. **14** to **19**. FIG. **14** is a schematic plane view showing the recording head part **16** viewed from above. (The plane view from above is employed for the sake of convenience upon parallelizing with FIG. **20**.)

As shown in FIG. **14**, the recording head part **16** basically has eight recording head arrays **42** arranged in the paper conveying direction (the direction shown by the arrow X in the figure, which is hereinafter sometimes referred to as a conveying direction) at a constant interval, and each of the recording head arrays **42** has six unit recording heads **40** arranged in the paper width direction (the direction shown by the arrow Y in the figure, which is hereinafter sometimes referred to as a width direction) perpendicular to the conveying direction at a constant interval.

As shown in FIG. **15**, the unit recording head **40** has nozzles **58** for ejecting an ink arranged in a straight form on the nozzle surface **40**A, ink droplets are ejected therefrom by a known thermal ink-jet system. In this example, the unit recording head **40** has 800 nozzles with a nozzle arrangement density of 800 dpi and an ejection frequency of 7.56 kHz and uses a pigment ink.

Six unit recording heads **40** are attached to a common substrate **46**, which will be described later, in a straight form in such a manner that the nozzle arranging direction of the unit recording heads 40 agrees with the width direction, so as to form the recording head arrays **42**A and **42**B.

As shown in FIG. **16**, the recording head arrays **42**A and **42**B each has six unit recording heads **40** arranged at a constant interval, and the arrangement of the unit recording heads **40** is deviated in the width direction between the recording head arrays **42**A and **42**B, whereby the rows of nozzles of the unit recording heads **40** partly overlap each other between the recording head arrays **42**A and **42**B. The overlapping areas OL thus provided prevent formation of a non-printing area in the printing area The nozzles **58** of the unit recording heads **40** of the pair of recording head arrays **42**A and **42**B eject ink droplets to print an image of one color on the paper. In this example, a combination of the pair of recording head arrays **42**A and **42**B is referred to as a recording head **44**.

The recording head **44** of this example has a printing area of **12** inches, which is wider than 297 mm, the shorter width of A3 size paper (i.e., the longer width of A4 size paper), which is the maximum paper width PW.

Plural recording heads **44** are arranged to print images of yellow (Y), magenta (M), cyan (C) and black (K) from the upstream of the conveying direction to attain full color printing, and symbols, Y, M, C and K, are attached to the reference number of the corresponding recording head (i.e., **44**Y, **44**M, **44**C and **44**K) depending on necessity to distinguish the recording heads, as shown in FIG. **14**. The nomenclature is also applied to the other members.

In FIG. **14**, because the recording heads **44**Y, **44**M, **44**C and **44**K have the same constitution, only constitutional elements of the recording head **44**Y are attached with reference symbols, and reference symbols for constitutional elements of the other recording heads **44**M, **44**C and **44**K are omitted.

As shown in FIG. **17**, the recording head array **42**A constituting the recording head **44** has six unit recording heads **40** attached at a prescribed interval to the common substrate **46**A extending in the paper width direction.

In other words, the unit recording heads **40** are attached to the common substrate **46**A, whereby the rows of nozzles are arranged in the width direction as shown in FIG. **16**.

The recording head array **42**A also has star wheels **70** adjacent in the width direction to the respective unit recording heads **40**. The star wheel **70** is pivotally supported elastically at a tip end of a supporting member **71**, which is engaged with the common substrate **46**A through a blade spring **73**, as shown in FIG. **18**.

As shown in FIG. **19**A, the star wheel **70** is constituted with a retaining member **76** formed with a resin having a cylindrical shape with a hole **74** formed therein, and a wheel **78** formed with stainless steel retained by the retaining member **76**.

The retaining member **76** is constituted with a first member **76**A having a diameter reduced at a center in the axial direction to enable insertion of the wheel, and a second member **76**B engaged in the part of the first member **76**A having the reduced diameter to hold the wheel **78** associated with the first member **76**A. The wheel **78** has a large number of teeth **79** on the outer periphery at a constant interval. The tooth **79** has an obtuse tip angle with a round tip end as shown in FIG. **19**B, but such a shape is sufficient that has a

reduced contact area as small as possible since it is in contact with an undried ink on the paper, and it may have, for example, an acute tip angle as shown in FIG. **19**C.

The thickness of the wheel **78** in this example is 0.1 mm, which is thinned by tapering to about from 0.01 to 0.02 mm at the tip end (tooth top) thereof. The wheel **78** is produced with a stainless steel material, SUS631EH, through stepwise etching on both surfaces to process the tip end shape and the taper shape simultaneously, and has a fluorine resin water-repellent coating on the surface.

In the recording head part **16**, groups of three star wheels **72**A to **72**C are arranged among the recording head arrays **42** along the conveying direction, on the upstream of the most upstream recording head array **42**YA, and on the downstream of the most downstream recording head array **42**KB, as shown in FIG. **14**. The groups of star wheels **72**A to **72**C each has six star wheels **70** pivotally supported with a prescribed interval by three shafts **74**A to **74**C, which are continuously arranged in the width direction. The shafts **74**A to **74**C are biased on both ends thereof with a spring **75** to a conveying roll **100** described later. The displacement amount of the star wheel **70** is restricted with a restriction member **77** to such an extent that the star wheel **70** is stopped at a position slightly breaking into the surface of the conveying roll **100** as shown in FIG. **18**.

The intervals of the star wheels **70** in the width direction are determined at 25.4 mm at most. This is because it is preferably 50 mm or less in order to suppress floatage and deformation locally occurring in the paper.

The force for pressing the star wheel **70** onto the conveying roll **100** with the spring **75** is 10 gf per one wheel. In the case where the pressing force is less than 5 gf, the paper cannot be sufficiently held on the conveying roll **100**, and in the case where it exceeds 30 gf, the star wheel **70** damages the paper.

Constitution of Maintenance Part

The constitution of the maintenance part **18** disposed opposite to the recording part **20** will be described with reference to FIGS. **20** to **25**. FIG. **20** is a schematic plane view showing the maintenance part **18** viewed from the conveying position.

The maintenance part **18** is disposed opposite to the recording part **20** with the paper conveying position intervening therebetween, and as shown in FIG. **20**, it has maintenance devices **81** arranged at positions opposite to the respective unit recording heads **40** of the recording part **20** as shown in FIG. **14**. The maintenance device **81** is constituted with a cap member **80** and a wiping member **88**.

As shown in FIG. **21**, the cap member **80** is constituted with a receiving member **82** formed with a PBT resin having a concave part **82**A of a rectangular shape with a depth of 8 mm, a rubber member **84** formed with silicone rubber (having a hardness of 40 Hs) on an upper part of the receiving member **82**, and an ink absorbent **86** formed with polypropylene and polyethylene disposed over the bottom of the concave part **82**A. Therefore, upon carrying out dummy jet described later, ink droplets are ejected from the nozzles **58** of the respective unit recording heads **40** to the interior of the concave part **82**A through an opening **84**A of the cap member **80**, and are absorbed with the ink absorbent **86**.

As shown in FIG. **22**, six cap members **80** corresponding to the unit recording heads **40** constituting the recording head array **42** are attached to a common substrate **300** and unitized, and they are constituted as they can integrally approach to and leave from the nozzle surface **40**A of the unit recording head **40** with an elevating mechanism **302**.

The elevating mechanism **302** is constituted with a driving motor **304** and an eccentric cam **308** attached to a driving axis **306** of the driving motor **304** and in contact with a lower surface of the common substrate **300**. Accordingly, the eccentric cam **308** is rotated upon driving the driving motor **304**, and thus the common substrate **300** in contact with the eccentric cam **308** approaches to and leaves from the nozzle surface **40**A of the unit recording head **40**.

The cap member **80** has, on the lower surface thereof, a spring **87** for adjusting the pressing force upon contacting with the nozzle surface **40**A as shown in FIG. **26**. Accordingly, upon capping operation described later, the cap member **80** is rises, and the rubber member **84** is pressed onto the nozzle surface **40**A to seal the nozzle surface **40**A including the nozzles **58**, whereby drying of the ink is suppressed, and attachment of dusts is prevented. Furthermore, upon wiping operation described later, the cap member **80** descends, whereby the wiping member **88** is made movable in the width direction.

The wiping member **88** for cleaning the nozzle surface **40**A of the unit recording head **40** is disposed at a position adjacent in the width direction to the cap member **80** as shown in FIGS. **21** and **22**.

As shown in FIG. **21**, the wiping member **88** is constituted with a retaining member **90** having a substantially gantry shape as viewed from the width direction, and a wiper **92** disposed on an upper part of the retaining member **90** and extending in the conveying direction.

The wiper **92** is formed with a thermoplastic polymer resin (having a hardness of 65 Hs) and has a length in the conveying direction L of 8 mm, a thickness in the width direction W**1** of 0.8 mm and a height from the retaining member **90** (free length) of 6 mm.

The retaining member **90** is formed with a stainless steel material.

The wiping member **88** is disposed at a position at 1 mm from the end of the cap member **80** in the width direction.

As shown in FIG. **22**, all the wiping member **5 88** corresponding to the respective unit recording heads **40** constituting the recording head array **42** are attached to a common substrate **310** and unitized, and they are constituted as they can integrally approach to and leave from the nozzle surface **40**A of the unit recording head **40** with a moving mechanism **312** and are movable in the width direction.

The moving mechanism **312** is basically constituted with a slider **314** supporting the common substrate **310** movably in the width direction, a driving motor **316** for moving the common substrate **310** on the slider **314** in the width direction, and a driving motor **318** for elevating the slider **314**. The slider **314** has guides **320**, which are provided on both ends in the conveying direction and extend in the width direction, and the common substrate **310** guided with the guides **320** is movable in the width direction. Protrusions **324** constituting a rack **322** are formed on one side surface of the common substrate **310**, with which a driving gear **326** of the driving motor **316** attached to the slider **314** is engaged. Accordingly, the common substrate **310** is movable on the slider **314** in the width direction by driving the driving motor **316**.

Protrusions **332** constituting a rack **330** extending in the vertical direction are provided on a lower surface of the slider **314**, with which a driving gear **334** of the driving motor **318** is engaged. Accordingly, the slider **314** can be elevated by driving the driving motor **318**. That is, the common substrate **310** and wiping members **88** supported by the slider **314** are integrally elevated.

According to the constitution, the wiping members **88** can approach to and leave from the nozzle surface **40**A and are movable in the width direction with the moving mechanism **312**. That is, the wiping member **88** (wiper **92**) in the home position is disposed at a position lower than the cap member **80** to prevent from interfering the paper thus conveyed (as shown in FIG. **23**A), and upon wiping, it rises and moves in the conveying direction by overstriding the cap member **80** thus descending from the home position to effect wiping (as shown in FIG. **23**C).

In order to prevent the paper penetrating into the concave part **82**A of the cap member **80** upon conveying the paper in the recording part **20**, guide members **94** are provided on both sides of the cap member **80** in the width direction as shown in FIG. **21**. The guide member **94** is formed with a stainless steel material and constituted with a horizontal part **94**A extending in the conveying direction, two vertical parts **94**B extending from both ends of the horizontal part **94**A in the vertical downward direction, and guide parts **94**C and **94**D extending from both ends in the conveying direction of the horizontal part **94**A in the obliquely downward direction toward the conveying direction as shown in FIG. **21**.

The horizontal part **94**A of the guide member **94** is disposed opposite to the star wheel **70** disposed between the unit recording heads as shown in FIGS. **14**, **20** and **18**). Accordingly, the paper thus conveyed is in contact with the guide member **94** (horizontal part **94**A) by the star wheel **70** at the printing position in the conveying direction, whereby the distance between the nozzle surface **40**A and the paper deformed by attachment of an ink or the like is maintained constant as shown in FIG. **18**.

Subsequently, the home position of the respective members constituting the maintenance device **81** in this example (i.e., the position where no maintenance is carried out on the unit recording head **40** during image printing) will be described.

The cap member **80** is disposed under the nozzle surface **40**A of the recording head **40**, whereby the rubber member **84** covers, in plane view, the entire nozzle surface **40**A of the unit recording head **40**, and all the nozzles **58** of the unit recording head **40** are positioned, in plane view, within the opening **84**A of the rubber member **84**.

The wiping member **88** is disposed in such a manner that the tip end of the wiper **92** is positioned under the nozzle surface **40**A of the unit recording head **40**, and disposed at such a position in that the longitudinal direction (in the conveying direction) of the wiper **92** covers, in plane view, the entire width in the conveying direction of the nozzle surface **40**A of the unit recording head **40**, and the wiper **92** is placed at a position apart from the end in the width direction of the unit recording head **40** by 1 mm (i.e., such a position in that the wiper can clean the recording head in the shorter width direction thereof).

The guide member **94** is disposed in such a manner that the uppermost surface of the horizontal part **94**A, which is in contact with the paper, is positioned under the nozzle surface **40**A of the unit recording head **40**, and disposed at such a position in that the length in the conveying direction of the horizontal part **94**A of the guide member **94** covers, in plane view, the nozzle surface **40**A of the unit recording head **40**, and the uppermost surface of the horizontal part **94**A, which is in contact with the paper, is placed at a position apart from the end in the width direction of the unit recording head **40** by 2 mm.

Subsequently, a mechanism for conveying the paper between the maintenance device **81** and the unit recording head **40** will be described.

Conveying rolls **100** for conveying the paper by transmitting a driving force thereto are disposed at both ends in the conveying direction and between the cap members **80** adjacent to each other in the conveying direction in the maintenance part **18** as shown in FIG. **20**. The conveying rolls **100** are disposed as corresponding to the disposed positions of the groups of star wheels **72**A to **72**C as shown in FIG. **18**, and the paper is made in contact with the conveying rolls **100** with the star wheels **70** of the groups of star wheels **72**A to **72**C, which are elastically pressed onto the side of the conveying rolls **100** with the springs **75**, so as to transmit the driving force from the conveying rolls **100** to the paper.

The conveying roll **100** is constituted with a small diameter part **100**A supported pivotally with a casing **102**, and a large diameter part **100**B, which has a larger diameter than the small diameter part **100**A and is in contact with the star wheel **72**, as shown in FIG. **17**. The conveying roll **100** transmits the driving force to the paper through the large diameter part **100**B, and is preferably those that have a large friction coefficient and are difficultly worn. The conveying roll **100** in this example is constituted with a metallic roll (SUS303) with a diameter of 10 mm having ceramic fine powder mainly containing alumina spray-coated thereon, followed by sintering, and satisfies the aforementioned requirements. The spray-coating is applied not only to the printing area of the large diameter part **100**B of the conveying roll **100**, which is in contact with the paper, but also to the non-printing area thereof, which is in contact with a flat belt **104**.

In order to prevent the tooth tops of the star wheel **70** from being deformed by contacting with the surface of the conveying roll **100**, a groove **101** having a width of 2 mm and a depth of 2 mm is provided at a part of the conveying roll **100** opposite to the star wheel **72** as shown in FIG. **18**. Furthermore, in order to prevent the paper conveying resistance from being increased upon increasing the penetrating amount of the star wheel **72** into the groove **101**, a restriction member **77** for restricting the penetrating amount of the star wheel **72** is provided as shown in FIG. **18**.

As shown in FIG. **24**, the driving mechanism for driving the conveying rolls **100** is constituted in such a manner that a flat belt **104** is stretched and wound on a driving shaft **108** of a single motor **106** to all the conveying rolls **100** through idler rolls **110** and **112**. Idler rolls **114** are disposed between the conveying rolls **100** adjacent to each other to ensure a wound angle of the flat belt on the respective conveying rolls **100** (large diameter parts **100**B).

As shown in FIG. **25**, the flat belt **104** is wound on the non-printing area outside the printing area in the large diameter part **100**B of the conveying roll **100**, with which the paper is in contact.

The single motor **106** is employed because of the following reason. In the case where plural motors are employed, the driving velocity and the fluctuation characteristics thereof of the respective motors are difficult to be made strictly uniform, and as a result, the fluctuation components in velocity are accumulated on the paper velocity, whereby the velocity fluctuation of the paper causes problems by accumulation of the velocity fluctuation of the motors even though the velocity fluctuation of the respective motors is sufficiently low. That is, the plural conveying rolls **100** are driven by the single driving source (ie., the motor **106**), whereby the conveying velocity of the paper is made uniform to attain printing with high quality.

The flat belt **104** transmits the driving force to the conveying rolls **100** without engagement of teeth (with a

frictional force), and therefore, it is particularly preferred since no periodical velocity fluctuation by every teeth occurs.

The flat belt **104** in this example has a thickness of 0.4 mm and is constituted with a base material formed by weaving polyester fibers having a thin film coating of polyurethane formed on one surface thereof, so as to attain both high mechanical strength and high friction.

According to the recording part **20** thus constituted in this example, the distance between the nozzle surface and the paper is designed to be 1.5 mm, and the paper is horizontally conveyed between them. The maximum recording area (i.e., the maximum paper width PW), to which the printing operation is applied, is a shorter width of A3 size paper (i.e., the longer width of A4 size paper). The recording part **20** has a process velocity of 240 mm/s, a printing resolution of 800×800 dpi, and a recording speed of 60 sheets per minute (in the case of long edge feed of A4 size paper (A4LEF)).

The function of the ink-jet recording apparatus **10** thus constituted as described in the foregoing will be described.

The printing operation and the maintenance operation (dummy jet, wiping and capping) will be sequentially described.

The printing operation will be firstly described. Upon-carrying out the printing operation, paper is fed from the paper feeding part **12**, and after controlling the orientation and the timing of the paper in the registration adjustment part **14**, the paper is dispatched to the recording part **20**.

In the recording part **20**, the motor **106** is driven, and the driving force is transmitted to all the conveying rolls **100** through the flat belt **104**.

Accordingly, the paper reaching the recording part **20** is inserted between the conveying roll **100** and the group of star wheels **72**A to **72**C disposed at the most upstream position in the conveying direction. At this time, the star wheel **70** of the group of star wheels **72**A to **72**C biased with the spring **75** presses the paper onto the conveying roll **100**, whereby the conveying force is certainly transmitted from the conveying roll **100** to the paper, and thus the paper is inserted into the lower part of the unit recording head **40** at a constant velocity. Subsequently, the driving force is sequentially transmitted from the conveying rolls **100** between the recording head arrays **42** to convey the paper.

Because all the conveying rolls **100** are driven with the single motor **106**, the paper is conveyed at a constant velocity, but it is prevented that accumulated velocity fluctuation of plural driving sources causes fluctuation of the conveying velocity of the paper as in the case where the conveying rolls are driven with plural driving sources. Periodic velocity fluctuation causing an image defect that can be visually recognized on an image is often caused by a problem on processing accuracy of teeth of gears, but because the flat belt **104** is used in this example for transmitting the driving force (without the use of engagement of teeth), such an image defect is prevented from occurring. Furthermore, because the flat belt **104** is wound on the non-printing area of the large diameter part **100**B of the conveying roll **100** in contact with the paper, no periodic velocity fluctuation occurs even in the case where the conveying roll **100** causes eccentricity due to the processing accuracy or the retaining system (such as bearings), and thus the paper is conveyed at the moving velocity (constant velocity) of the flat belt **104**. In the constitution where the idler roll **114** is disposed to ensure the wound angle of the flat belt **104**, periodic velocity fluctuation occurs due to the processing accuracy or the retaining system of the idler roll **114** in the strict sense, but the idler roll **114** can be easily processed with high accuracy at low cost because it has a relatively small size and may be formed with a single material. The conveying roll **100**, on the other hand, has a large size and has a constitution containing plural materials including, for example, the core metal and the covering material, and therefore, it is difficult to be processed with high accuracy or becomes a considerably expensive member. The driving system using surface friction with the flat belt **104** has such an effect that even in the case where fluctuation in the radius and the rotational center of the conveying roll **100** occurs, no periodic fluctuation in velocity is caused thereby.

Furthermore, because the group of star wheels **72**A to **72**C is divided into three parts in the width direction to reduce the length of the shafts **74**A to **74**C thereof, deflection of the shafts can be prevented to press the paper evenly with the plural star wheels **70** biased with the springs **75**. Accordingly, the driving force can be evenly transmitted to the paper.

In particular, because the paper is pressed onto the conveying roll **100** with the star wheels **70**, the driving force is certainly transmitted to the paper to ensure conveying at a constant velocity. In particular, owing to the nonuse of an electrostatic sorption system, stable conveying can be attained irrespective to the thickness and the material of the paper.

Moreover, because the star wheel **70** is disposed between the unit recording heads **40** in the width direction, and the guide member **94** is disposed at a position opposite thereto, floatage and the like of the paper can be prevented at the printing position (at the recording head array **42**) in the conveying direction, whereby the planarity of the paper (i.e., a constant distance to the nozzle surface **40**A) is ensured.

In other words, the provision of the star wheel **70** ensures the planarity of the paper (i.e., a constant distance to the nozzle surface **40**A) even in the case where the maintenance device **81** including the cap member **80** and the like is disposed at the position opposite to the unit recording head **40**.

Upon inputting a printing signal to the unit recording heads **40** of the recording head part **16** from a controlling part of the apparatus, a heating element of the nozzle corresponding to the printing signal generates heat, whereby an ink droplet is ejected from the nozzle to the paper conveyed with a constant distance to the nozzle surface **40**A.

Accordingly, printing is carried out with the recording head array **42**A, and subsequently, printing is carried out with the recording head array **42**B, so as to complete printing in one color on the corresponding part of the paper. Upon conveying the paper in the recording part **20**, printing is sequentially carried out with the recording heads **44**Y, **44**M, **44**C and **44**K to effect full color printing.

As described in the foregoing, the planarity of the paper (i.e., a constant distance to the nozzle surface **40**A) is ensured, and printing is carried out on the paper conveyed at a constant velocity, whereby an image of high image quality can be formed. In particular, because the planarity is stably ensured with the star wheel **70** during conveying in the recording part **20**, deformation caused during printing on various kinds of paper having variation in thickness can be favorably corrected, and thus the distance to the nozzle surface **40**A can be maintained to a constant value to attain printing with high image quality.

In particular, in the recording part **20**, the conveying rolls **100** are disposed between the recording head arrays **42** and also disposed on the upstream of the most upstream recording head array **42**YA and on the downstream of the most

downstream recording head array **42**KB, and the plural conveying rolls **100** are driven with the single driving source. Consequently, the paper is certainly conveyed at a constant velocity to attain printing with high image quality.

The operation of dummy jet will be then described.

The dummy jet is carried out upon non-printing or after every times of completion of printing of a prescribed number of sheets during continuous printing of plural sheets of paper but before reaching an edge of subsequent paper. That is, ejection of an ink droplet is carried out from an arbitrary nozzle among all the unit recording heads **40** constituting the recording heads **44**Y to **44**K to the cap member **80** (i.e., so-called dummy jet). The dummy jet may be carried out for all the nozzles of all the unit recording heads **40**, for all the nozzles **58** of the selected unit recording head **40** or the selected recording head array **42**, or only for such a nozzle **58** that has not ejected an ink droplet for a prescribed period of time.

For example, the distance between the nozzle surface **40**A and the upper surface of the cap member **80** upon carrying out the dummy jet during continuous printing of plural sheets of paper is set at 3 mm, and 500 droplets are ejected from all the nozzles, respectively, at the time between passage of preceding recording paper and arrival of subsequent recording paper by 30 sheets pf A4 size paper.

At this time, the provision of the ink absorbent **86** at the bottom of the concave part **82**A of the cap member **80** prevents the thus-ejected ink from suffering flood and splash from the concave part **82**A.

For example, the change in ejection performance due to drying of an ink (particularly, an aqueous ink and a solvent ink) can be initialized by ejecting ink droplets (dummy jet) from all the nozzles of the unit recording head **40**. Even in the case of an oily ink and a solid ink, which are substantially not dried, the dummy jet can remove bubbles attached to the ink flow path inside the head and dusts attached on the nozzle surface upon printing, whereby the ejection performance of ink droplets of the nozzles can be initialized.

The printing speed (productivity) is improved in this example because the dummy jet can be carried out during continuous printing of plural sheets of paper thus conveyed without movement of the recording head **44** and the cap member **80**. Furthermore, the printing performance of the recording head **44** can be constantly maintained by the dummy jet to enable printing with high image quality.

The wiping operation will be described.

The wiping operation is carried out before starting printing. The recording head **40** (nozzle surface **40**A) is wiped with the wiping member **88** of the maintenance part **18**. The specific operation will be described based on the schematic figures shown in FIGS. **23**A to **23**G.

The driving motor **304** of the elevating mechanism **302** shown in FIG. **22** is firstly driven to bring down the common substrate **300** by rotation of the eccentric cam **306**. The driving motor **318** of the moving mechanism **312** is driven to raise the slider **314** and the common substrate **310** supported by the slider **314**. Accordingly, the six cap members **80** attached to the common substrate **300** descend from the home position (i.e., moving in the direction of leaving from the recording head **40**), and the six wiping member **88** attached to the common substrate **310** rise from the home position (i.e., moving in the direction of approaching the nozzle surface **40**A of the recording head **40**), as shown in FIGS. **23**A and **23**B.

In this example, the cap member **80** descends to the position at 6 mm from the nozzle surface **40**A of the unit recording head **40**, and the tip end (upper end) of the wiper **92** of the wiping member **88** rises to the position higher than the nozzle surface **40**A by 1.5 mm (hereinafter, referred to as a contact amount of 1.5 mm).

As a result, the retaining member **90** of the wiping member **88** becomes movable by overstriding the cap member **80** in the width direction. The wiper **92** of the wiping member **88** is in such a state that it overlaps the nozzle surface **40**A of the recording head **40** in the vertical direction (the direction shown by the arrow Z in FIGS. **23**A to **23**G) as shown in FIG. **23**B.

In this state, the driving motor **316** of the moving mechanism **312** shown in FIG. **22** is driven to move the common substrate **310** in the width direction on the slider **314** through the rack **322** engaged with the driving gear **326**. Accordingly, the wiping member **88** attached to the common substrate **310** is moved in the width direction, whereby the wiper **92** of the wiping member **88**, the tip end of which is at a position higher than the nozzle surface **40**A, is moved with slidably contacting with the nozzle surface **40**A of the unit recording head **40**. As a result, dusts and a dried ink attached to the nozzle surface **40**A are removed as shown in FIG. **23**C. At this time, the wiping member **88** is moved by overstriding the cap member **88** thus having descended.

In this example, the wiper **92** is in slidably contact with the nozzle surface **40**A with maintaining the contact amount of 1.5 mm, whereby contamination attached to the nozzle surface **40**A is certainly removed.

The wiping member **88** then escapes from the area under the nozzle surface **40**A to complete the movement of the wiping member **88** and the guide member **94** in the width direction as shown in FIG. **23**D. Subsequently, the common substrate **310**, i.e., the wiping member **88**, is brought down by driving the driving motor **318** of the moving mechanism **312** to move to the height of the home position as shown in FIG. **23**E.

The common substrate **310**, i.e., the wiping member **88**, is then moved to the opposite side in the width direction by driving the driving motor **318** of the moving mechanism **312** shown in FIG. **20** to make it revert to the home position as shown in FIG. **23**F. Furthermore, the cap member **80** is raised by driving the driving motor **304** of the elevating mechanism **302** to make it revert to the home position near the nozzle surface **40**A of the recording head **40**, whereby the wiping operation is completed as shown in FIG. **23**G.

Subsequently, the capping operation will be described.

The capping operation is carried out in the case where the non-printing state continues for a long period of time, or in the case where the power of the apparatus is turned off. Specifically, the driving motor **304** of the elevating mechanism **302** shown in FIG. **22** is driven to raise the common substrate **300** to press the rubber member **84** of the cap member **80** attached to the common substrate **300** onto the nozzle surface **40**A of the recording head **40** as shown in FIGS. **26**A and **26**B. As a result, the airtightness of the nozzle surface **40**A (i.e., the nozzles **58**) is ensured, whereby increased viscosity and drying of the ink are prevented, and attachment of dusts is also prevented.

As shown in FIG. **16**, the recording head **44** in this example is constituted by attaching the recording head arrays **42**A and **42**B formed by arranging plural short unit recording heads **40** to the common substrates **46**A and **46**B, respectively, whereby the production thereof can be standardized as with inexpensive devices (recording heads), which are mass-produced, and the recording head **40** capable of printing on the entire width can be produced at low cost.

Furthermore, the recording head arrays **42**A and **42**B are attached to the common substrates **46**A and **46**B, respec-

tively, whereby the constitutions of the recording head arrays **42**A and **42**B are simplified, and thus the production and the adjustment in high accuracy thereof can be conveniently carried out. Furthermore, there is such an advantage that the constitution of the maintenance part (including the cap member **80** and the wiping member **88**) can be standardized as with those used in a recording head of a short length. Moreover, there is also such an advantage that a unit for making constant the distance between the nozzle surface **40**A and the paper (e.g., the star wheel **70** in this example) can be disposed by utilizing the gap (space) among the unit recording heads in the width direction, or the degree of freedom in designing the arrangement of the cap member **80** can be increased by that gap (space).

While one cap member **80** is provided as corresponding to one unit recording head **40** in this example, only one cap member **80** may be provided as corresponding to plural unit recording heads **40**.

EXAMPLE 2

An ink-jet recording apparatus according to Example 2 of the invention will be described. The same constitutional elements as in the aforementioned embodiment and Example 1 are attached with the same symbols, and detailed descriptions thereof are omitted herein. The description will be made by focusing on the differences from Example 1.

In the maintenance part (including the cap members **80** and the wiping members **88**) shown in FIGS. **25**, **27**A and **27**B, the unit recording heads **40** are arranged in a staggered form to form spaces R with the casing **102**, toward which the common substrates **310** are moved, and also sliding mechanisms **315** disposed at the ends of the common substrates **310** are opposite to each other between the adjacent common substrates **310**.

As shown in FIG. **21**, in the guide members **94** disposed on both sides in the width direction of the cap member **80**, an ink absorbent **95** is provided on the lower surface of the horizontal part **94**A constituting the guide member **94** and extending in the conveying direction of the paper. As shown in FIG. **29**, a depressed housing part **93** having a substantially horseshoe cross section is provided on the lower surface of the horizontal part **94**A of the guide member **94**, and the ink absorbent **95** having a substantially rectangular shape is detachably inserted in the housing part **93**. As shown in FIG. **30**, the wiping member **88** passes under the guide member **94**, whereby the wiper **92** of the wiping member **88** is in slidably contact with the ink absorbent **95** (which is described later).

Examples of a material of the ink absorbent **95** include, as similar to the ink absorbent **86** (shown in FIG. **21**), a polyester felt fibrous material and an acrylonitrile felt fibrous material, and a mixture of a polyester felt fibrous material and an acrylonitrile felt fibrous material can also be preferably used. The ink holding capability of the ink absorbent **95** can be finely adjusted by changing the fiber diameter, the fiber length and the arranging direction of the fibrous material used.

Examples thereof also include a polyamide fibrous material, a polypropylene fibrous material, a polyvinyl alcohol fibrous material, a polyvinylidene chloride fibrous material and a polyurethane fibrous material.

A polyester fibrous material is preferably used from the standpoint of absorbance of a recording liquid, such as an ink, and a mixed system of these materials may also be preferably used.

The operation of the wiping member **88** in this example will be described with reference to FIGS. **22** and **28**B. Descriptions for the overlap with Example 1 will be simplified.

As shown in FIGS. **23**A and **23**B, the wiping member **88** rises from the home position (step **100**), and the cap member **80** descends from the home position (i.e., moves in a direction leaving from the unit recording head **40**) (step **102**). As shown in FIG. **23**C, the wiper **92** of the wiping member **88** is in slidably contact with the nozzle surface **40**A of the unit recording head **40** to start wiping (step **104**).

As shown in FIG. **23**D, the wiping member **88** completes the movement in the width direction to stop movement of the wiping member **88** (step **106**), and then as shown in FIG. **23**E, the wiping member **88** descends to move the height of the home position (step **108**).

In this example, thereafter, the common substrate **310** is moved on the slider **314** in the width direction (the same direction as the cleaning direction of the nozzle surface **40**A) by driving the driving motor **316** of the moving mechanism **312** driven through the rack **322** engaged with the driving gear **326**.

According to the operation, as shown in FIG. **23**F, the wiping member **88** passes under the guide member **94** (step **114**) to make the wiper **92** of the wiping member **88** in slidably contact with the ink absorbent **95**, followed by stopping the movement of the wiping member **88** (step **116**).

After reverting the wiping member **88** to the home position (step **110**) as shown in FIG. **23**H, the cap member **80** rises to be reverted to the home and completes the wiping operation position as shown in FIG. **23**I (step **112**).

According to the operation, the wiping member **88** moves from the home position, cleans the nozzle surface **40**A of the unit recording head **40**, leaves from the recording head **40**, descends downward to leave from the unit recording head **40**, and then passes under the guide member **94** disposed on the moving path of the wiping member **88** (in the same direction as the cleaning direction of the nozzle surface **40**A) to be slidably in contact with the ink absorbent **95** of the guide member **94**, and the wiping member **88** then moved to the opposite side to go back to the home position.

The function of the ink-jet recording apparatus **10** thus constituted as described in the foregoing will be described.

At the end of the common substrate **310** shown in FIG. **22**, it is necessary to ensure a space for disposing the sliding mechanism **315**. In the case where the sliding mechanisms **315** for all the common substrates **310** are disposed on the same side, it is necessary that at least the adjacent sliding mechanisms **315** are prevented from interfering with each other to impair space saving.

However, in the case where the sliding mechanisms **315** of the common substrates **310** are disposed opposite to each other between the adjacent common substrates **310** as shown in FIG. **27**A, the sliding mechanisms **315** can be prevented from interfering with each other since the sliding mechanisms **315** are not adjacent to each other. Therefore, the distance between the adjacent common substrates **310** can be reduced to attain space saving.

The unit recording heads **40** are, arranged in a staggered form (i.e., the cap members **80** arranged to face the unit recording heads **40** are also arranged in a staggered form) to form spaces R with casing **102** (as shown in FIG. **25**), toward which the common substrates **310** are moved, whereby the spaces R can be effectively used.

As shown in FIG. **21**, the ink absorbent **95** is provided in the guide member **94** to make the wiper **92** of the wiping member **88** in slidably contact with the ink absorbent **95**,

whereby the ink attached to the wiper **92** can be removed. In the case where the ink remains attached to the wiper **92**, the ink is accumulated thereon to impair the cleaning function of the wiper **92**. Therefore, the removal of the ink attached to the wiper **92** not only maintains the cleaning function of the wiper **92** but also prolongs the service life of the wiper **92**.

Upon continuously recovering the ink by the ink absorbent **95** from the wiper **92**, the ink penetrates into the interior of the ink absorbent **95** to lower the ink absorbing function gradually. However, the ink absorbent **95** can be appropriately replaced since the ink absorbent **95** is detachably inserted in the guide member **94**.

Because the guide member **94** is positioned on the same straight line as the cap member **80** and the wiping member **88**, by imposing the ink absorbent **95** on the guide member **94** the ink absorbent **95** removing contamination of the wiping member **88** is thus disposed on the moving path of the wiping member **88**. According to the configuration, there is no necessity to equip the wiping member **88** with another ink suction device or the like for removing the contamination of the wiping member **88**, whereby the ink absorbent **95** can function through the wiping operation to simplify the mechanism.

EXAMPLE 3

An ink-jet recording apparatus according to Example 3 of the invention will be described. The same constitutional elements as in the aforementioned embodiment and Examples 1 and 2 are attached with the same symbols, and detailed descriptions thereof are omitted herein. The description will be made by focusing on the differences from. Examples 1 and 2.

In the maintenance device **81**, as shown in FIG. **31**, thin belts **120** are stretched between the adjacent conveying rolls **100** for ensuring the planarity at the printing position, instead of the guide members **94** in Examples 1 and 2. That is, the thin belt **120** is stretched between the unit recording heads **40**, between which the guide member **94** and the wiping member **88** have been disposed in Examples 1 and 2.

Star wheels **70** are disposed opposite position as similar to Examples 1 and 2 (as shown in FIG. **32**). In this example, the thin belt **120** is a polyurethane belt having a width of 5 mm and a thickness of 2 mm.

The wiping member **88**A is disposed on the downstream side in the paper conveying direction with respect to the cap member **80**. As shown in FIG. **32**, in the transmission of the driving force to the conveying roll **100**, the driving force is transmitted by a flat belt **104** stretched between the driving shaft **108** of the DC motor **106** and the large diameter part **100**B of the conveying roll **100** on the most downstream side in the conveying direction, and then transmitted to the other conveying rolls **100** through the thin belt **120** stretched on the large diameter parts **100**B of the conveying rolls **100**. As a result, all the conveying rolls **100** are driven at the same velocity.

The cap members **80** and the wiping members **88**A in this example are disposed as shown in FIGS. **31**, **33** and **34**, i.e., six cap members **80** and six wiping members **88**A arranged in one line in the width direction are attached to the common substrates **300** and **310**A, respectively, and the moving mechanism **312**A has basically the same constitution as the moving mechanism **312** shown in FIG. **22**.

However, in order that the wiping member **88**A moves in the conveying direction of the paper, a stem **89** of the wiping member **88**A is formed to have a substantially L-shape, whereby the common substrate **310**A moves above the cap members **80**A in the conveying direction of the paper.

That is, a driving motor **318**A is attached to one end of the common substrate **310**A, and a driving gear **334**A directly connected thereto is engaged with a rack **330**A set up on the side of the casing **102** (shown in FIG. **31**). Consequently, the common substrate **310**A can be elevated.

A rack **33** is disposed on the casing **102** perpendicular to the rack **330**A. A driving motor **316**A is attached to the rack **330**A, and a driving gear **326**A directly connected to the driving motor **316**A is engaged with the rack **333**, whereby the common substrate **310**A is movable in the conveying direction of the paper.

As shown in FIG. **31**, a retaining member **97** retaining the ink absorbent **95** (shown in FIG. **29**) moves with the moving path of the wiping member **88**A to the side of the cap member **80** opposite to the wiping member **88**A.

Since the retaining member **97** is disposed in a direction perpendicular to the conveying direction of the paper, the height of the retaining member **97** is set at a level lower than the conveying path for conveying the paper to prevent it from impairing the convey of the paper, and there is no necessity to provide a guide part for guiding the paper on both ends of the horizontal part of the retaining member **97**.

In this example, a unit for sucking an ink from the concave part **82**A of the receiving part **82** of the cap member **80** through a hole provided in the ink absorbent **86**, as shown in FIG. **21**, and as shown in FIG. **33**, a first waste ink recovering tank **132** (having a capacity of 4 cc) connected to the concave part **82**A of the receiving part **82** of each of the cap members **80** through a flow path **130** is provided under the respective cap member **80**.

Furthermore, a second waste ink recovering tank **136** (having a capacity of 60 cc) connected to six first waste ink recovering tanks, **132** corresponding to six cap members **80** arranged in the straight form in the width direction through flow paths **134** is provided.

Furthermore, a third waste ink recovering tank **140** connected to eight second waste ink recovering tanks **136** through flow paths **138** is provided. The third waste ink recovering tank **140** can discharge the waste ink to the exterior through a flow path **142** and is connected to a vacuum pump **146** through a filter **144**. The third waste ink recovering tank **140** can be measured for negative pressure with a negative pressure measuring device **148**.

A first electromagnetic switching valve **150**, a second electromagnetic switching valve **152** and a third electromagnetic switching valve **154** are provided on the flow paths **130**, **134** and **142**, respectively, and can be selectively switched.

Accordingly, the waste ink accumulated in the cap member **80** (concave part **82**A) is recovered by driving the vacuum pump **146** and switching the electromagnetic switching valves **150**, **152** and **154**, or the ink on the nozzle surface **40**A or inside the nozzles **58** can be sucked with the vacuum operation described later.

The function of the ink-jet recording apparatus **10** thus constituted will be described. The descriptions for the similar operation as in Examples 1 and 2 are omitted herein, and only the vacuum operation will be described.

As shown in FIGS. **35**A, **35**B, **36**A and **36**B (in which FIGS. **35**A and **36**A are side views, and FIGS. **35**B and **36**B are elevational views), the cap member **80** at the home position is raised by driving the elevating unit **302** (shown in FIG. **34**) to be pressed onto the nozzle surface **40**A of the

unit recording head **40**. As a result, the receiving part **82** of the cap member **80** covers and seals the nozzle surface **40**A airtightly.

A negative pressure is supplied to the cap member **80** in this state. Specifically, the following operation is carried out.

The first electromagnetic switching valves **150** provided on the flow paths **130** and the third electromagnetic switching valve **154** provided on the flow path **142** are closed as shown in FIG. **33**. The vacuum pump **146** is driven until the measured pressure with the negative pressure measuring device **148** reaches the prescribed value. At the time when the measured pressure reaches −70 kPa with respect to the atmospheric pressure, the driving of the vacuum pump **146** is terminated. According to the operation, a prescribed negative pressure is applied to the first to third waste ink recovering tanks **132**, **136** and **140**. The second electromagnetic switching valves **152** are then closed.

At this time, the first electromagnetic switching valve **150** is released that is provided on the flow path **130** connected to the first waste ink recovering tank **132** corresponding to the cap member **80** or the unit recording head **40**, in which the ink is to be recovered. According to the operation, the concave part **82**A of the cap member **80** (shown in FIG. **34**) is connected to the first waste ink recovering tank **132** applied with a negative pressure, whereby the ink accumulated in the concave part **82**A of the receiving member **82**, the ink and dusts attached to the nozzle surface **40** having been sealed airtightly with the rubber part **84**, and the ink having an increased viscosity present inside the nozzles **58** are sucked with the negative pressure to be recovered in the first waste ink recovering tank **132**.

Subsequently, the cap member **80** is brought down by driving the elevating mechanism **302** (shown in FIG. **34**) to make it revert to the home position (i.e., leaving from the nozzle surface **40**A), and all the first electromagnetic switching valves **150** and the second electromagnetic switching valves **152** are closed, so as to recover the waste ink in the cap member **80**, the first waste ink recovering tanks **132** and the second waste ink recovering tanks **136** to the third waste ink recovering tank **140** applied with a negative pressure.

Accordingly, the ink (waste ink) accumulated in the concave part **82**A of the cap member **80** can be recovered by applying a negative pressure to the concave part **82**A of the recording head **80**, and bubbles and the ink having an increased viscosity in the nozzles **58** can be removed by sucking the ink from the nozzles **58** (shown in FIG. **16**).

The wiping operation in this example is the same as in Examples 1 and 2 except for the wiping direction, which is in the conveying direction in this example. Therefore, figures for describing the operation are shown in FIGS. **37**A to **37**I, in which the specific procedures of the operation are the same as in FIGS. **23**A to **23**I, but detailed descriptions are omitted herein.

On the other hand, as shown in FIG. **32**, the motor **106** is driven in the recording part **20**, whereby the driving force is transmitted to the conveying roll **100** on the most downstream side through the flat belt **104**. Among the conveying rolls **100** adjacent to each other, the thin belt **120** is stretched, whereby the conveying rolls **100** are driven at the same velocity.

As shown in FIG. **18**, the star wheels **70** of the group of star wheels **72** are biased onto the side of the conveying rolls **100** with the springs **75**, whereby the paper thus conveyed is made into contact with the conveying rolls **100** by pressing with the star wheels **70** and is conveyed at a constant velocity by transmitting the prescribed driving force from the conveying rolls **100**.

As shown in FIG. **33**, the driving force is transmitted among the conveying rolls **100** through the thin belt **120**, whereby the paper is certainly conveyed at a constant velocity, and the planarity of the paper at the printing position is ensured.

In this example, six cap members **80** and six wiping members **88**A arranged in the width direction are attached to the common substrates **300** and **310**A (shown in FIG. **34**), respectively, which can be integrally moved, so as to provide such an advantage that the driving mechanism can be simplified. This example also exerts the similar effects as in Examples 1 and 2.

The vacuum operation and the mechanisms therefor described in this example may be applied to Examples 1 and 2.

EXAMPLE 4

An ink-jet recording apparatus according to Example 4 of the invention will be described. The same constitutional elements as in Examples 1, 2 and 3 are attached with the same symbols, and detailed descriptions thereof are omitted herein. The description will be made by focusing on the differences from Examples 1, 2 and 3.

The ink-jet recording apparatus **400** according to this example uses, as one of significant characteristics, an electrostatic sorption drum (hereinafter, sometimes simply referred to as a drum) **160** is used as a conveying system as shown in FIG. **38**.

The drum **160** has a semiconductive or insulating sheet provided on a paper retaining area on the outer peripheral surface thereof, which is charged with a charging roll **162** disposed on the upstream side in the conveying direction, and paper is electrostatically adsorbed on the drum **160** by pressing onto the drum **160** with a pressing roll **164**, and is rotationally conveyed associated with the drum **160** by the rotation of the drum **160**, followed by being released from the outer peripheral surface of the drum with a releasing unit **166** disposed on the downstream side in the conveying direction.

An opening **160**A is provided at a position different from the paper retaining area on the outer peripheral surface of the drum **160** and is used upon the maintenance operation (including dummy jet, wiping, capping and vacuum operations).

Eight recording head arrays **42**YA to **42**KB constituting recording heads **44**Y to **44**K of four colors are arranged along the rotational direction on the outer peripheral surface of the drum **160**. The constitutions of the respective recording head arrays **42** are the same as in Examples 1 to 3.

Cap members **80** are disposed inside the drum **160** at positions opposite to the unit recording heads **40**, and wiping members **88** are disposed at position adjacent in the width direction to the cap members **80**. The arrangements thereof are the same as in Examples 1 and 2.

Six cap members **80** and six wiping members **88** arranged in the width direction are attached to the same common substrates **404** and **410**, as similar to Examples 1 and 2, and can be integrally moved with the elevating mechanism **402** and the moving mechanism **415**.

The function of the ink-jet recording apparatus **400** thus constituted will be described.

Upon printing, the paper retaining area of the drum **160** is charged with the charging drum **162**, and the paper pressed to the outer peripheral surface of the drum **160** with the pressing roll **164** is electrostatically adsorbed on the outer

peripheral surface of the drum **160** and is conveyed by rotating associated with the drum **160**.

Ink droplets are ejected to the paper from the nozzles **58** of the unit recording heads **40** constituting the respective recording head arrays **42**YA to **42**KB to attain color printing. The paper having been printed in color is released from the outer peripheral surface of the drum **160** with the releasing unit **166**.

The paper is conveyed by electrostatically adsorbed on the paper retaining area on the drum **160**, whereby the distance between the nozzle surfaces **40**A of the respective unit recording heads **40** and the paper can be maintained at a constant value to attain full color printing with high image quality.

Upon carrying out the dummy jet operation, on the other hand, ink droplets are ejected from the nozzles **58** to the cap members **80** (i.e., dummy jet is carried out) at a time when the opening **160**A reaches the position opposite to the unit recording head **40** after the passage of the paper retaining area on the drum **160**. According to the operation, the printing performance can be initialized.

Upon carrying out the capping, vacuum and wiping operations, the rotation of the drum **160** is terminated at a position where the opening **160**A is opposite to all the unit recording heads **40**, and the capping, vacuum and wiping operations are then carried out with the elevating mechanism **402** and the moving mechanism **415** in the same manner as in Examples 1 and 2.

In particular, there is no necessity of moving the recording heads **44**Y to **44**K for carrying out the maintenance operation, whereby misalignment of the printing position due to movement of the recording heads **44**Y to **44**K causing deviation in printing is prevented from occurring to attain printing with high image quality. There is also such an advantage that no mechanism is necessary for moving the recording heads **44**Y to **44**K, so as to simplify the mechanism.

In the recording apparatus of the invention, the term "recording medium" as a target of image recording encompasses wide variety of materials, to which ink droplets are ejected from the recording apparatus. Patterns formed with dots on the recording medium obtained by attaching ink droplets to the recording medium are included in the "image" and the "recorded image" obtained with the recording apparatus of the invention. Therefore, the recording apparatus of the invention is not limited to those used for recording characters and images on recording paper.

The recording medium includes not only recording paper and an OHP sheet, but also, for example, a substrate, on which a wiring pattern is to be formed. The "image" includes a general image (including characters, pictures and photographs) and also the aforementioned wiring pattern, a three-dimensional object, an organic thin film and the like. The liquid thus ejected is not limited to a coloring ink.

For example, the recording apparatus of the invention can be applied to general liquid droplet ejecting apparatuses for various kinds of industrial purposes, such as production of a color filter for a display attained by ejecting a coloring ink on a polymer film or glass, production of bumps for mounting electronic parts on a substrate attained by ejecting molten solder on the substrate, production of an EL display panel attained by ejecting an organic EL solution on a substrate, and production of bumps for electric implementation attained by ejecting molten solder on a substrate.

The effect of the recording apparatus according to the invention will be described.

The recording medium is conveyed between the recording head and the maintenance device by the conveying unit, whereby a liquid droplet is ejected from the recording head to the recording medium to effect printing on the recording medium. Because the maintenance device is disposed at a position opposite to the liquid droplet ejecting surface of the recording head, there is no necessity of moving the recording head for carrying out the maintenance operation, and thus the maintenance operation can be effectively carried out. For example, dummy jet can be effected by ejecting a liquid droplet from the recording head to the liquid housing unit within a period between passage of a preceding recording medium and arrival of a subsequent recording medium. Furthermore, the liquid droplet ejecting surface of the recording head can be cleaned by operating the cleaning unit, whereby the liquid droplet ejection performance can be well maintained.

Moreover, because there is no necessity of moving the recoding head for carrying out the maintenance operation, fluctuation of printing quality due to misalignment in the maintenance operation does not occur to maintain the printing quality constantly. The constitution of the apparatus can also be simplified owing to the non necessity of the mechanism for moving the recording head for maintenance.

Accordingly, printing with high image quality can be carried out with high productivity while maintaining the good liquid droplet ejection performance of the recording head. Further, the maintenance operation can be carried out with a relatively simplified constitution.

The entire disclosure of Japanese Patent Application No. 2003-295649 filed on Aug. 19, 2003 including specification, claims, drawings and abstract is incorporated herein by reference in its entirety.

What is claimed is:

1. A recording apparatus comprising:

a recording head having a liquid droplet ejecting surface, the recording head ejecting a liquid droplet to a recording medium;

a maintenance device disposed at a position opposite to the liquid droplet ejecting surface of the recording head; and

a conveying unit which conveys the recording medium between the recording head and the maintenance device,

the recording head having a printing width larger than a width of the recording medium, and

the maintenance device comprising a liquid housing unit which houses the liquid droplet from the recording head, and a cleaning unit which cleans the liquid droplet ejecting surface of the recording head.

2. The recording apparatus as claimed in claim **1**, wherein the maintenance device comprises a cap unit being capable of approaching to and leaving from the liquid droplet ejecting surface of the recording head and having a concave part which seals airtightly the liquid droplet ejecting surface upon being in contact thereto.

3. The recording apparatus as claimed in claim **2**, wherein the liquid housing unit is the concave part of the cap unit.

4. The recording apparatus as claimed in claim **1**, wherein the cleaning unit is capable of approaching to and leaving from the liquid droplet ejecting surface and has a contact part comprising an elastic body that is movable along the liquid droplet ejecting surface upon being in contact thereto.

5. The recording apparatus as claimed in claim **1**, wherein the maintenance device comprises a recovering unit that recovers the liquid fed to the recording head.

6. The recording apparatus as claimed in claim 5, wherein the recovering unit is a negative pressure inducing device which recovers the liquid by applying a negative pressure to a concave part of the maintenance device.

7. The recording apparatus as claimed in claim 5, wherein the recovering unit is a liquid absorbent disposed in a concave part of the maintenance device.

8. The recording apparatus as claimed in claim 1, wherein the maintenance device comprises a plurality of cap units, being capable of approaching to and leaving from the liquid droplet ejecting surface of the recording head and having a concave part which seals airtightly the liquid droplet ejecting surface upon being in contact thereto, wherein the plurality of cap units are integrally driven.

9. The recording apparatus as claimed in claim 1, wherein the maintenance device comprises a plurality of cleaning units, wherein the cleaning units are integrally driven.

10. The recording apparatus as claimed in claim 2, wherein the cap unit and the cleaning unit are driven as being capable of moving relatively to each other.

11. The recording apparatus as claimed in claim 1, wherein the recording head is fixed.

12. The recording apparatus as claimed in claim 1, wherein the recording head is constituted with a plurality of unit recording heads.

13. The recording apparatus as claimed in claim 12, wherein the recording head is constituted by combining a plurality of recording head arrays, each of which is constituted with the plurality of unit recording heads arranged in a width direction.

14. The recording apparatus as claimed in claim 13, wherein the conveying unit for the recording medium is disposed among the plurality of recording head arrays or between the plurality of unit recording heads.

15. The recording apparatus as claimed in claim 13, wherein a liquid droplet is ejected to the liquid housing unit by each of the plurality of recording head arrays constituting the recording head.

16. The recording apparatus as claimed in claim 13, wherein the plurality of recording head arrays are arranged in the conveying direction of the recording medium, and the plurality of unit recording heads are arranged in a staggered form in plane view.

17. The recording apparatus as claimed in claim 12, wherein a liquid droplet is ejected to the liquid housing unit by each of the plurality of unit recording heads constituting the recording head.

18. The recording apparatus as claimed in claim 1, wherein the recording apparatus comprises a plurality of recording heads that are arranged in a conveying direction of the recording medium.

19. The recording apparatus as claimed in claim 18, wherein the cleaning unit is controlled as being capable of cleaning the recording heads disposed at different positions in the conveying direction.

20. The recording apparatus as claimed in claim 18, wherein the plurality of recording heads eject liquids having different colors.

21. The recording apparatus as claimed in claim 18, wherein a liquid droplet is ejected to the liquid housing unit by each of the plurality of recording heads.

22. The recording apparatus as claimed in claim 1, wherein a liquid droplet is ejected to the liquid housing unit from a nozzle of the recording head, the nozzle having ejected no liquid droplet during recording.

23. The recording apparatus as claimed in claim 1, further comprising:

a removing member that removes contamination attached to the cleaning unit by contacting with the cleaning unit, disposed on a moving path of the cleaning unit.

24. A recording apparatus comprising:

a recording head array comprising a plurality of unit recording heads ejecting liquid droplets and arranged in a width direction of a conveyed recording medium with a constant interval;

a cleaning unit that cleans a liquid droplet ejecting surface of the unit recording head; and

a driving unit having a plurality of cleaning units that move integrally the cleaning units in an arranging direction of the plurality of unit recording heads or in a direction perpendicular to the arranging direction.

25. The recording apparatus as claimed in claim 24, wherein the driving unit comprises:

a first support having the plurality of cleaning units attached thereto; and

a driving device that elevates the first support and moves the plurality of cleaning units in an arranging direction of the plurality of unit recording heads or in a direction perpendicular to the arranging direction.

26. The recording apparatus as claimed in claim 25, wherein the driving unit comprises a plurality of first supports, wherein driving directions of the plurality of first supports are opposite to each other in respective recording head arrays adjacent to each other.

27. The recording apparatus as claimed in claim 25, wherein disposing positions of a plurality of driving units for respective first supports adjacent each other are opposite to each other in respective recording head arrays adjacent to each other.

28. The recording apparatus as claimed in claim 25, wherein the cleaning unit rises from the first support, and upon moving the first support in the arranging direction of the plurality of unit recording heads or in a direction perpendicular to the arranging direction, the cleaning unit comprises a second gantry shape flame over a cap unit and a contact part attached to an upper surface of a beam of the second gantry shape flame.

29. The recording apparatus as claimed in claim 28, further comprising:

a second support comprising a plurality of cap units, and an elevating unit that elevates the second support,

wherein the elevating unit elevates the second support to move the plurality of cap units among a capping position where the liquid droplet ejecting surface is capped, a recording position lower than the capping position where the recording medium is capable of being conveyed, and a cleaning position lower than the recording position where the second gantry shape flame is capable of moving thereover.

30. A recording apparatus comprising:

a recording head having a liquid droplet ejecting surface, the recording head ejecting a liquid droplet to a recording medium;

a maintenance device disposed at a position opposite to the liquid droplet ejecting surface of the recording head;

a conveying unit which conveys the recording medium between the recording head and the maintenance device, and

a removing member that removes contamination attached to the cleaning unit by contacting with the cleaning unit, disposed on a moving path of the cleaning unit,

the maintenance device comprising a liquid housing unit which houses the liquid droplet from the recording head, and a cleaning unit which cleans the liquid droplet ejecting surface of the recording head, and

the removing member comprising a first gantry shape flame disposed over first support and

a liquid droplet absorbent attached to a lower surface of a beam of the first gantry shape flame and being in slidably contact with the cleaning unit.

31. The recording apparatus as claimed in claim **30**, wherein the liquid droplet absorbent is exchangeable.

32. The recording apparatus as claimed in claim **30**, wherein the beam of the first gantry shape flame extends between a plurality of recording head arrays and is positioned between a plurality of unit recording heads to function as a guide part that guides the recording medium conveyed.

33. The recording apparatus as claimed in claim **30**, wherein a driving device elevates and moves the first support comprising a plurality of cleaning units in the arranging direction of a plurality of unit recording heads to clean the liquid droplet ejecting surface with the plurality of cleaning units, and then brings down the first support to make the plurality of cleaning units in slidably contact with the liquid droplet absorbent of the first gantry shape flame, followed by being reverted to a home position.

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